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AERONAUTICS

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics.*

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For related information see also *34 Fluid Mechanics and Heat Transfer.*

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Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

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For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

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20 SPACECRAFT PROPULSION AND POWER **2820**

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For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

CHEMISTRY AND MATERIALS

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55 SPACE BIOLOGY N.A.

Includes exobiology; planetary biology; and extraterrestrial life.

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Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics.* For space plasmas see *90 Astrophysics.*

76 SOLID-STATE PHYSICS 2943
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For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

77 THERMODYNAMICS AND STATISTICAL PHYSICS 2946
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

80 SOCIAL SCIENCES (GENERAL) 2947
Includes educational matters.

81 ADMINISTRATION AND MANAGEMENT 2947
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82 DOCUMENTATION AND INFORMATION SCIENCE 2949
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.
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83 ECONOMICS AND COST ANALYSIS N.A.
Includes cost effectiveness studies.

84 LAW, POLITICAL SCIENCE AND SPACE POLICY N.A.
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

85 URBAN TECHNOLOGY AND TRANSPORTATION 2950
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
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SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
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89 ASTRONOMY 2951
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Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

91 LUNAR AND PLANETARY EXPLORATION 2954
Includes planetology; and manned and unmanned flights.
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92 SOLAR PHYSICS 2955
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Includes cosmic radiation; and inner and outer earth's radiation belts.
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Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

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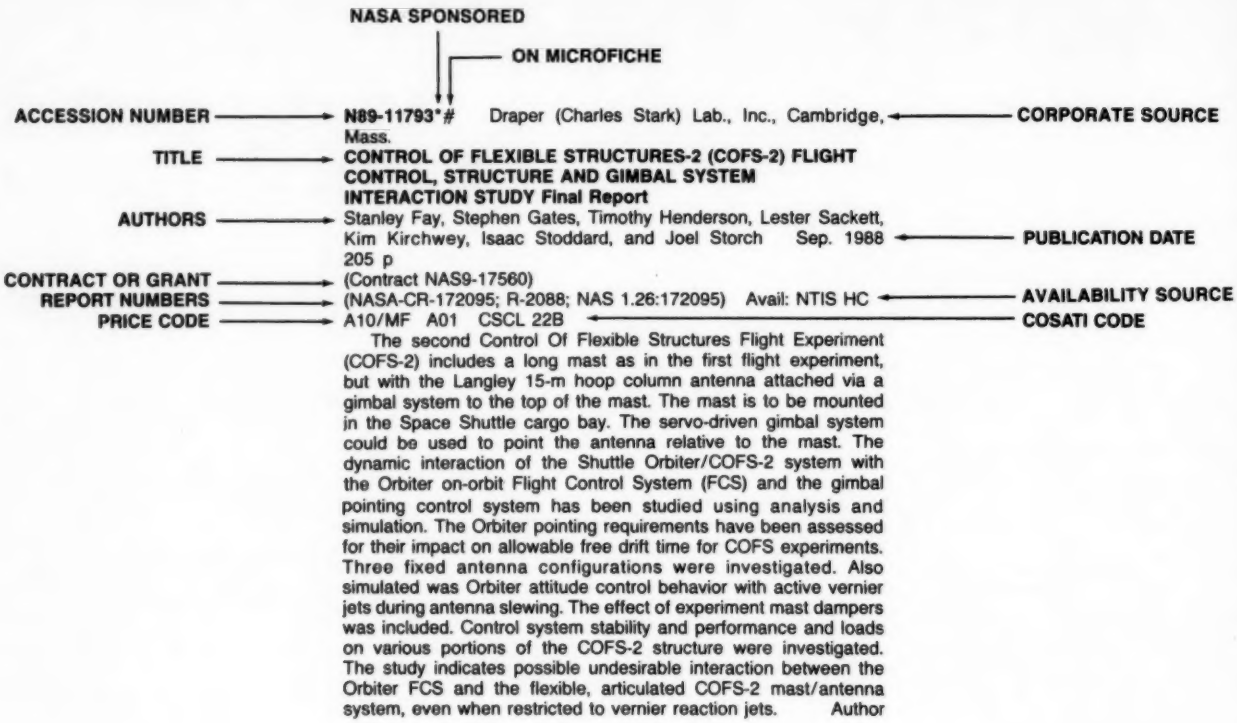
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ACCESSION NUMBER
N89-11793*# Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
CORPORATE SOURCE
TITLE
CONTROL OF FLEXIBLE STRUCTURES-2 (COFS-2) FLIGHT CONTROL, STRUCTURE AND GIMBAL SYSTEM INTERACTION STUDY Final Report
AUTHORS
Stanley Fay, Stephen Gates, Timothy Henderson, Lester Sackett, Kim Kirchwey, Isaac Stoddard, and Joel Storch Sep. 1988
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REPORT NUMBERS
(NASA-CR-172095; R-2088; NAS 1.26:172095) Avail: NTIS HC
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COSATI CODE
The second Control Of Flexible Structures Flight Experiment (COFS-2) includes a long mast as in the first flight experiment, but with the Langley 15-m hoop column antenna attached via a gimbal system to the top of the mast. The mast is to be mounted in the Space Shuttle cargo bay. The servo-driven gimbal system could be used to point the antenna relative to the mast. The dynamic interaction of the Shuttle Orbiter/COFS-2 system with the Orbiter on-orbit Flight Control System (FCS) and the gimbal pointing control system has been studied using analysis and simulation. The Orbiter pointing requirements have been assessed for their impact on allowable free drift time for COFS experiments. Three fixed antenna configurations were investigated. Also simulated was Orbiter attitude control behavior with active vernier jets during antenna slewing. The effect of experiment mast dampers was included. Control system stability and performance and loads on various portions of the COFS-2 structure were investigated. The study indicates possible undesirable interaction between the Orbiter FCS and the flexible, articulated COFS-2 mast/antenna system, even when restricted to vernier reaction jets. Author

VOLUME 27 NUMBER 20 / OCTOBER 23, 1989

Scientific and Technical Aerospace Reports

A Semimonthly Publication of the National Aeronautics and Space Administration

01 AERONAUTICS (GENERAL)

N89-25948# Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.
FAA (FEDERAL AVIATION ADMINISTRATION) AVIATION FORECASTS: FISCAL YEARS 1989-2000
Mar. 1989 252 p
(AD-A206716; FAA-APO-89-1) Avail: NTIS HC A12/MF A01 CSCL 01/2

This report contains forecasts of aviation activity at FAA facilities. These include airports with FAA control towers, air route traffic control centers, and flight service stations. Detailed forecasts were made for the four major users of the NAtional Aviation System: air carriers, air taxi/commuters, general aviation and the military. The forecasts were prepared to meet the budget and planning needs of the constituent units of the FAA and to provide information that can be used by state and local authorities, by the aviation industry, and by the general public. The overall outlook for the forecast period is for continued economic growth, rising real fuel prices, and moderate inflation. Based upon these assumptions, aviation activity by fiscal year 2000 is forecast to increase by 31.0 percent at towered airports (commuters, 51.8 percent; air carriers, 34.6 percent; general aviation, 27.5 percent; military, 0.0 percent), 32.0 percent at air route traffic control centers (commuters, 55.2 percent; air carriers, 33.7 percent; general aviation, 30.0 percent military, 0.0 percent, and 7.8 percent in flight services performed. Hours flown by general aviation are forecast to increase 14.9 percent and helicopter hours flown, 82.6 percent. Scheduled domestic revenue passenger miles (RPM's) are forecast to increase 73.6 percent, with scheduled international RPM's forecast to increase by 104.9 percent; and regionals/commuters RPM's forecast to increase by 158.7 percent. GRA

N89-25949# Logistics Management Inst., Bethesda, MD.
AIRCRAFT SUSTAINABILITY MODEL VERSION 1.5: USERS MANUAL
Frank L. Eichorn Mar. 1989 45 p
(Contract MDA903-85-C-0139)
(AD-A207015; LMI-AF801R2) Avail: NTIS HC A03/MF A01 CSCL 15/5

The Aircraft Sustainability Model (ASM) is an item-specific inventory model that relates investments for spares to aircraft sortie generation capability during a conflict. An important advantage of the ASM is its ability to produce an entire curve relating a wide range of investment levels to the resulting sortie generation capability, allowing Air Force planners to trade off spares investment and capability. Moreover, the algorithm that builds the curve explicitly trades off investment in line replaceable units installed directly on aircraft versus their constituent shop replaceable unit subassemblies. These features, together with the computational efficiency of the code, have led to rapid acceptance of the ASM within the Air Force Logistics Command (AFLC). AFLC is now incorporating the ASM into the Requirements Execution Availability Logistics Module (REALM) of the Weapon System Management Information System (WSMIS). The ASM is being used in WSMIS/REALM to compute item requirements and to execute the Air Force budget for the reparable spares portion of War Reserve Materiel (WRM). This users manual explains the use of the PC-version of the ASM, Version 1.5. GRA

02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

N89-25950# National Aerospace Lab., Tokyo (Japan).
A NUMERICAL SOLUTION OF TRANSONIC FLOW USING DISCONTINUOUS SHOCK WAVE RELATIONSHIP
Masayoshi Nakamura Sep. 1988 18 p In JAPANESE; ENGLISH summary
(NAL-TR-997; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

It is the purpose of this study to obtain solutions, which contain complete discontinuities of shock waves, of the potential equations for transonic airfoils using numerical techniques. For iterative calculations, the potential equations are transformed into a more convenient form of simultaneous equations having two variables, velocity potential and Mach number. The solutions with the complete discontinuities of shock waves satisfying shock wave relationship are obtained by the iterative calculations without divergencies or high frequencies under a grid system in the physical plane. Numerical results of the present techniques, and of another method for the transonic flow over an airfoil of NACA0012 with shock wave, are used as test cases for comparison. Author

N89-25951*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STEADY-STATE AND TRANSITIONAL AERODYNAMIC CHARACTERISTICS OF A WING IN SIMULATED HEAVY RAIN
Bryan A. Campbell and Gaudy M. Bezos Washington Aug. 1989 95 p
(NASA-TP-2932; L-16576; NAS 1.60:2932) Avail: NTIS HC A05/MF A01 CSCL 01A

The steady-state and transient effects of simulated heavy rain on the subsonic aerodynamic characteristics of a wing model were determined in the Langley 14- by 22-Foot Subsonic Tunnel. The 1.29 foot chord wing was comprised of a NACA 23015 airfoil and had an aspect ratio of 6.10. Data were obtained while test variables of liquid water content, angle of attack, and trailing edge flap angle were parametrically varied at dynamic pressures of 10, 30, and 50 psf (i.e., Reynolds numbers of .76x10(6), 1.31x10(6), and 1.69x10(6)). The experimental results showed reductions in lift and increases in drag when in the simulated rain environment. Accompanying this was a reduction of the stall angle of attack by approximately 4 deg. The transient aerodynamic performance during transition from dry to wet steady-state conditions varied between a linear and a nonlinear transition. Author

N89-25952# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
FLOW CHARACTERISTICS ABOUT A TRAILING EDGE Ph.D. Thesis

Dwayne S. Smith Mar. 1989 112 p
(UTIAS-TN-270; ISSN-0082-5263) Avail: NTIS HC A06/MF A01

The mandate was to determine the mean and turbulent flow quantities of an attached, fully-developed boundary layer of an aft-loaded airfoil. The steady, two-dimensional flow characteristics of the near and far wake were also studied. This was done to gain an understanding of the viscous effects near the trailing edge of the airfoil in the hope of providing accurate data for airfoil performance models. Tests were conducted at a Reynolds number of 1.7 million based on chord and a Mach number of 0.14. The airfoil model on loan from Boeing of Canada's deHavilland Division was restricted to zero incidence and the boundary layer was artificially tripped at 0.075c. Artificial tripping was employed to provide a well-defined transition location over that of free transition for numerical analysis. The hot-wire anemometer measurements taken in the boundary layer and wake near the trailing edge reveal that a complex interaction takes place just aft of the airfoil where the upper and lower surface flows combine. The boundary layer thickness was found to increase quickly over the last few percent chord with a corresponding increase in turbulence intensity. The extreme asymmetry in the near wake profile was seen to transform into an essentially symmetric profile by approximately X/C= 1.075. such as, skin friction coefficients, displacement Author

N89-25953*# Eloret Corp., Sunnyvale, CA.
EXPERIMENTAL AND COMPUTATIONAL FLOW-FIELD RESULTS FOR AN ALL-BODY HYPERSONIC AIRCRAFT
Technical Progress Report, 1 Oct. 1988 - 31 Mar. 1989
Joseph W. Cleary 7 Jun. 1989 30 p Presented at the 6th National Aero-Space Plane Technology Symposium, 24-28 Apr. 1989
(Contract NCC2-416)
(NASA-CR-185347; NAS 1.26:185347) Avail: NTIS HC A03/MF A01 CSCL 01A

A comprehensive test program is defined which is being implemented in the NASA/Ames 3.5 foot Hypersonic Wind Tunnel for obtaining data on a generic all-body hypersonic vehicle for computational fluid dynamics (CFD) code validation. Computational methods (approximate inviscid methods and an upwind parabolized Navier-Stokes code) currently being applied to the all-body model are outlined. Experimental and computational results on surface pressure distributions and Pitot-pressure surveys for the basic sharp-nose model (without control surfaces) at a free-stream Mach number of 7 are presented. K.C.D.

N89-25954*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE ACOUSTICS OF A SMALL-SCALE HELICOPTER ROTOR IN HOVER
Cahit Kitaplioglu Apr. 1989 96 p
(NASA-TM-101058; A-89015; NAS 1.15:101058) Avail: NTIS HC A05/MF A01 CSCL 01A

A 2.1 m diameter, 1/6-scale model helicopter main rotor was tested in hover in the test section of the NASA Ames 40- by 80-foot wind tunnel. Performance and noise data on a small-scale rotor at various thrust coefficients and tip Mach numbers were obtained for comparison with existing data on similar full-scale helicopter rotors. These data form part of a data base to permit the estimation of scaling effects on various rotor noise mechanisms. Another objective was to contribute to a data base that will permit the estimation of facility effects on acoustic testing. Acoustic 1/3-octave-band spectra are presented, together with variations of overall acoustic levels with rotor performance, microphone distance, and directivity angle. Author

N89-25955*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
IMPLEMENTATION OF A HYPERSONIC RAREFIED FLOW PARTICLE SIMULATION ON THE CONNECTION MACHINE
Leonardo Dagum (Stanford Univ., CA.) Dec. 1988 28 p
(Contract NCC2-387)
(NASA-CR-185428; NAS 1.26:185428; RIACS-TR-88.46) Avail: NTIS HC A03/MF A01 CSCL 01A

A very efficient direct particle simulation algorithm for hypersonic rarefied flows is presented and its implmentation on a Connection Machine is described. The implementation simulates ideal diatomic Maxwell molecules with three translational and two rotational degrees of freedom. Results for a 2-D simulation of supersonic flow over a 30 deg wedge are presented and used for validation. Author

N89-25956*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
ZONAL MULTIGRID SOLUTION OF COMPRESSIBLE FLOW PROBLEMS ON UNSTRUCTURED AND ADAPTIVE MESHES
Final Report
Dimitri J. Mavriplis May 1989 26 p Submitted for publication
(Contracts NAS1-18107; NAS1-18605)
(NASA-CR-181848; ICASE-89-35; NAS 1.26:181848) Avail: NTIS HC A03/MF A01 CSCL 01A

The simultaneous use of adaptive meshing techniques with a multigrid strategy for solving the 2-D Euler equations in the context of unstructured meshes is studied. To obtain optimal efficiency, methods capable of computing locally improved solutions without recourse to global recalculations are pursued. A method for locally refining an existing unstructured mesh, without regenerating a new global mesh is employed, and the domain is automatically partitioned into refined and unrefined regions. Two multigrid strategies are developed. In the first, time-stepping is performed on a global fine mesh covering the entire domain, and convergence acceleration is achieved through the use of zonal coarse grid accelerator meshes, which lie under the adaptively refined regions of the global fine mesh. Both schemes are shown to produce similar convergence rates to each other, and also with respect to a previously developed global multigrid algorithm, which performs time-stepping throughout the entire domain, on each mesh level. However, the present schemes exhibit higher computational efficiency due to the smaller number of operations on each level. Author

N89-25957*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INFLUENCE OF THICKNESS AND CAMBER ON THE AEROELASTIC STABILITY OF SUPERSONIC THROUGHFLOW FANS: AN ENGINEERING APPROACH
John K. Ramsey Jun. 1989 22 p
(NASA-TM-101949; E-4642; NAS 1.15:101949) Avail: NTIS HC A03/MF A01 CSCL 01A

An engineering approach was used to include the nonlinear effects of thickness and camber in an analytical aeroelastic analysis of cascades in supersonic acial flow (supersonic leading-edge locus). A hybrid code using Lighthill's nonlinear piston theory and Lanes's linear potential theory was developed to include these nonlinear effects. Lighthill's theory was used to calculate the unsteady pressures on the noninterference surface regions of the airfoils in cascade. Lane's theory was used to calculate the unsteady pressures on the remaining interference surface regions. Two airfoil profiles was investigated (a supersonic throughflow fan design and a NACA 66-206 airfoil with a sharp leading edge). Results show that compared with predictions of Lane's potential theory for flat plates, the inclusion of thickness (with or without camber) may increase or decrease the aeroelastic stability, depending on the airfoil geometry and operating conditions. When thickness effects are included in the aeroelastic analysis, inclusion of camber will influence the predicted stability in proportion to the magnitude of the added camber. The critical interblade phase angle, depending on the airfoil profile and operating conditions, may also be influenced by thickness and camber. Compared with predictions of Lane's linear potential theory, the inclusion of thickness and camber decreased the aerodynamic stifness and increased the aerodynamic damping at Mach 2 and 2.95 for a cascade of supersonic throughflow fan airfoils oscillating 180 degrees out of phase at a reduced frequency of 0.1. Author

N89-25958*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PERFORMANCE AND LOADS DATA FROM AN OUTDOOR HOVER TEST OF A LYNX TAIL ROTOR
David B. Signor, Gloria K. Yamauchi, Charles A. Smith, and Martin J. Hagen Jun. 1989 63 p
(NASA-TM-101057; A-89014; NAS 1.15:101057) Avail: NTIS HC A04/MF A01 CSCL 01A

A Lynx tail rotor was tested in hover at the Outdoor Aerodynamic Research Facility at NASA Ames Research Center. The test objectives were to measure the isolated rotor performance to provide a baseline for subsequent testing, and to operate the rotor throughout the speed and collective envelope before testing in the NFAC 40- by 80-Foot Wind Tunnel. Rotor forces and blade bending moments were measured at ambient wind conditions from zero to 6.23 m/sec. The test envelope was limited to rotor speeds of 1550 to 1850 rpm and minus 13 deg to plus 20 deg of blade collective pitch. The isolated rotor performance and blade loads data are presented. Author

N89-25959*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DEVELOPMENT OF A NAVIER-STOKES ALGORITHM FOR PARALLEL-PROCESSING SUPERCOMPUTERS Ph.D. Thesis - Colorado State Univ., Dec. 1988
Julie M. Swisshelm May 1989 170 p
(NASA-TM-102188; A-89121; NAS 1.15:102188) Avail: NTIS HC A08/MF A01 CSCL 01A

An explicit flow solver, applicable to the hierarchy of model equations ranging from Euler to full Navier-Stokes, is combined with several techniques designed to reduce computational expense. The computational domain consists of local grid refinements embedded in a global coarse mesh, where the locations of these refinements are defined by the physics of the flow. Flow characteristics are also used to determine which set of model equations is appropriate for solution in each region, thereby reducing not only the number of grid points at which the solution must be obtained, but also the computational effort required to get that solution. Acceleration to steady-state is achieved by applying multigrid on each of the subgrids, regardless of the particular model equations being solved. Since each of these components is explicit, advantage can readily be taken of the vector- and parallel-processing capabilities of machines such as the Cray X-MP and Cray-2. Author

N89-25960*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
RAREFIED-CONTINUUM GAS DYNAMICS TRANSITION FOR SUMS PROJECT Final Report
Sin-I Cheng May 1989 125 p
(Contract NAS1-17234)
(NASA-CR-181826; NAS 1.26:181826) Avail: NTIS HC A06/MF A01 CSCL 01A

This program is to develop an analytic method for reducing SUMS data for the determination of the undisturbed atmosphere conditions ahead of the shuttle along its descending trajectory. It is divided into an internal flow problem, an external flow problem and their matching conditions. Since the existing method of Direct Simulation Monte Carlo (DSMC) failed completely for the internal flow problem, the emphasis is on the internal flow of a highly non-equilibrium, rarefied air through a short tube of a diameter much less than the gaseous mean free path. A two fluid model analysis of this internal flow problem has been developed and studied with typical results illustrated. A computer program for such an analysis and a technical paper published in Lecture Notes in Physics No. 323 (1989) are included as Appendices 3 and 4. A proposal for in situ determination of the surface accommodation coefficients sigma sub t and sigma e is included in Appendix 5 because of their importance in quantitative data reduction. A two fluid formulation for the external flow problem is included as Appendix 6 and a review article for AIAA on Hypersonic propulsion, much dependent on ambient atmospheric density, is also included as Appendix 7. Author

N89-25961# Aerospace Corp., El Segundo, CA. Aerophysics Lab.
AERODYNAMIC SIDE FORCE INDUCED BY NOZZLE ENTRANCE FLOW ASYMMETRY
Robert L. Varwig, James S. Whittier, Donald A. Durran, Rudolf X. Meyer, and Edward K. Ruth 1 Oct. 1988 30 p
(Contract F04701-85-C-0086)
(AD-A206631; TR-0088(3470-02)-1; SD-TR-89-12) Avail: NTIS HC A03/MF A01 CSCL 20/4

The Star 48 upper stage rocket motor and payload system appears to precess in a coning motion which affects the flight path. The coning motion has been attributed to side forces generated because of deviations of the rocket nozzle entrance flow from truly axisymmetric conditions. In this report, an experimental investigation is described in which intentional nozzle entrance flow misalignment was produced and consequent side force was measured on a model at a simulated altitude of 170,000 ft. Side forces generated with an approximately 1/50th scale Star 48 rocket nozzle were quite small when compared to the predictions and measurements of previous investigators, but the difference was attributed to the difference where the flow inclination or misalignment occurs. When the flow is inclined at the nozzle throat, the downstream effect of the inclination is predictably large. When the flow is inclined in the plenum upstream of the nozzle entrance, the downstream effect is smaller by an order of magnitude. The observed side forces show a dependence on the nozzle length, as indicated by earlier investigators. GRA

N89-25962# Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
BASIC INSTABILITY MECHANISMS IN CHEMICALLY REACTING SUBSONIC AND SUPERSONIC FLOWS Final Scientific Report, 30 Sep. 1983 - 31 Dec. 1988
Tau-Yi Toong 8 Feb. 1989 21 p
(Grant AF-AFOSR-0373-83; AF Proj. 2308)
(AD-A206669; AFOSR-89-0414TR) Avail: NTIS HC A02/MF A01 CSCL 21/2

This report summarizes the main results and conclusions of research on turbulent combustion. The main objective was to determine and elucidate the mechanisms governing turbulence-combustion interactions in different spectral regimes. Problems studied included: (1) structure of disturbed flames; (2) evolution of turbulence-combustion interactions; and (3) thermal and flow structures of turbulent premixed V-flames at low Damkoehler numbers. In an experimental investigation, simultaneous measurements of velocity and temperature in premixed, rod-stabilized, lean methane-air V-flames demonstrated the presence of high-frequency fluctuations within slowly drifting flame brushes, leading to temporal changes in flame shapes, thicknesses and propagation speeds. Cross-correlation coefficients of these simultaneous signals assumed high values within the reaction zone, suggesting the possibility that these fluctuations might be induced by the same governing mechanism. A theoretical study showed the importance of wrinkling-like effects as well as the effects of chemical reaction rate on the evolution of fluctuations in a reacting shear layer. The direct rate-augmentation effects due to reaction led to changes in phase relationships between the various fluctuations, resulting in turbulent energy and mass transport in a direction opposite to that suggested by the gradient model. GRA

N89-25963# Ballistic Research Labs., Aberdeen Proving Ground, MD.
ANALYSIS OF TURBULENT BOUNDARY-LAYER OVER ROUGH SURFACES WITH APPLICATION TO PROJECTILE AERODYNAMICS
James E. Danberg and Asher Sigal (Technion - Israel Inst. of Tech., Haifa.) Dec. 1988 63 p
(DA Proj. 1L1-62618-AH-80)
(AD-A206747; BRL-TR-2977) Avail: NTIS HC A04/MF A01 CSCL 01/1

A new correlation of the roughness density effect on the intercept of the law of the wall and the equivalent sand roughness,

has been developed. The data base used includes corrected results of Schlichting's rough channel experiment and those of twelve other studies. The roughness density parameter used is a product of the reference surface to the total frontal area ratio and a shape factor. For two-dimensional roughness, the new parameter correlates data for circular wires with that of square bars. For three-dimensional roughnesses, it correlates results from all four types of roughness studied by Schlichting. The effect of three-dimensional roughness is a little smaller than that of two-dimensional roughness, having the same density parameter. A component build-up engineering analysis has been used to estimate the additional axial-force, due to grooves and threads, of projectiles. Comparison of this prediction technique and wind-tunnel data shows good agreement. Because the groove roughness, in the case considered here, is beyond the range of applicability of the new correlation, existing data are used to estimate an equivalent sand roughness. A turbulence model, based on that of Healzer and the equivalent sand roughness concept has been implemented in the Schiff and Steger parabolized Navier-Stokes (PNS) code. In order to numerically evaluate the conditions over a rough surface, a transition region between smooth and rough surfaces is introduced. This transition region allows the effect of the rough surface conditions to propagate into the viscous flow region in a realistic way. GRA

N89-25964# Ohio Univ., Athens. Dept. of Mechanical Engineering.
AN EXPERIMENTAL INVESTIGATION OF HIGH LIFT/HIGH RATE AERODYNAMICS OF AN UNSTEADY AIRFOIL Final Report, 1 Sep. 1987 - 31 Dec. 1988
G. M. Graham Mar. 1989 49 p
(Grant AF-AFOSR-0312-87; AF Proj. 2307)
(AD-A206964; AFOSR-89-0438TR) Avail: NTIS HC A03/MF A01 CSCL 01/1

An experimental study of a two dimensional NACA 0015 airfoil undergoing both positive and negative constant pitch rate motions at high angles of attack was conducted in the Ohio University tow tank facility. Nondimensional pitch rates in the range of 0.1 greater than K greater than 0.7 and Reynolds numbers in the range of 141,000 greater than Re greater than 342,000 were considered. Test results consist of lift and drag force coefficients and flow visualizations. The results of this study provide insight into the airfoil-dynamic stall vortex interaction during the pitch down motion and the cessation of aerodynamic stall. These data may be useful in high angle of attack applications such as the enhanced maneuverability concept for fighter aircraft. GRA

N89-25965# Winzen International, Inc., San Antonio, TX.
LONG DURATION BALLOON TECHNOLOGY SURVEY, PHASE 1 Final Report, 11 Aug. 1988 - 28 Feb. 1989
Pamela G. Scott, Thomas M. Lew, James S. Wilbeck, James L. Rand, and Richard H. Brezinsky 17 Mar. 1989 66 p
(Contract DAAH01-88-C-0715; ARPA Order 5916)
(AD-A206975; WII-9942-01-TR-01) Avail: NTIS HC A04/MF A01 CSCL 01/3

This feasibility study addresses the design and fabrication of a long endurance balloon vehicle capable of supporting 50 pounds at 120,000 feet for up to one year. The concept makes use of the experience gained by the scientific community over the past two decades in flying smaller payloads for long periods of time. The result of the effort is a prototype balloon which has a better lift to weight ratio than previous designs. This was achieved by the use of a novel shape (multiple intersecting spheres) and the use of a material new in the area of ballooning (Emblem, a biaxially oriented Nylon 6). This film demonstrates very high strength without displaying the susceptibility of prior films to pinholing. Other results of the effort are two analytical tools and specialized fabrication techniques. The analytical tools are a heat transfer model for predicting maximum and minimum super-temperatures of the balloon gas, and mechanical model to design the superpressure balloons for particular flight scenarios. GRA

N89-25966# Institut Franco-Allemand de Recherches, Saint-Louis (France).
VORTICES AND PRESSURE WAVES AT PLATES, CYLINDERS AND WIND PROFILES [WIRBEL UND DRUCKWELLEN AN PLATTEN, ZYLINDERN UND TRAGFLUEGELPROFILEN]
F. Seiler, J. Srulijes, and A. George 19 Jan. 1988 37 p In GERMAN
(ISL-R-102/88; ETN-89-94853) Avail: NTIS HC A03/MF A01

Vortex behavior and Karman vortex street formation behind wing profiles in a shock tube are studied and visualized by differential interferometry. Precise image quality flow visualization allows observation of recompression shock waves together with pressure waves. For a wing profile in a hard incident subsonic flow an asymmetric vortex distribution around the wings is observed. Pressure waves are determined on the underside of the wing; the upward side is free of shock and pressure waves. ESA

N89-25967# Manchester Univ. (England). Aeronautical Engineering Group.
SURFACE SINGULARITY DISTRIBUTIONS ON A CIRCLE: AN ALTERNATIVE TO THE MILNE-THOMSON CIRCLE THEOREM
P. G. Bellamy-Knights, M. G. Benson, J. H. Gerrard, and I. Gladwell Dec. 1987 16 p
(AERO-Rept-8711; ETN-89-94951) Avail: NTIS HC A03/MF A01

Analytical solutions for surface singularity distributions for the special case of a circular cylinder, which provide a benchmark test for algorithms designed for more general shapes, were derived. The separated flow past a circular cylinder is discussed. If the panel method approach is adopted for this flow, the analysis gives exact solutions for the singularity distribution and so it is unnecessary to solve a linear matrix equation for approximate values of the singularity distribution at discrete points. Thus, algorithms for the convection process can be made more accurate and economical by incorporating the presented results. ESA

N89-25968# Manchester Univ. (England). Dept. of Engineering.
REPORT ON THE WORKSHOP ON THE USE OF LIQUID CRYSTALS IN FLIGHT AND THE WIND TUNNEL
A. W. Bloy Mar. 1988 51 p Workshop held in Farnborough, United Kingdom, 24 Feb. 1988
(AERO-Rept-8801; ETN-89-94952) Avail: NTIS HC A04/MF A01

Properties of liquid crystals; liquid crystal flow visualization techniques for hypersonic flows; heat transfer and shear stress flow measurements using liquid crystals; experience in the use of liquid crystals for determining transition and flow separation on wind tunnel models; experiences with liquid crystals for measuring drag; and the use of video digitization techniques for use with shear stress measurements using liquid crystals were discussed. ESA

N89-25969# Manchester Univ. (England). Aeronautical Group.
AN INITIAL ASSESSMENT OF THE IMPACT OF BOUNDARY LAYER CONTROL ON SST
D. I. A. Poll and S. R. Bunting 1988 17 p
(AERO-Rept-8802; ETN-89-94953) Avail: NTIS HC A03/MF A01

The implications of establishing laminar flow on a vehicle traveling at supersonic speed are considered. A simple analysis is used to estimate the magnitudes of the different components which make up the total aircraft drag and to determine how the relative importance of each component changes with increasing flight Mach number. Special consideration is given to the effect of laminarization on the equilibrium surface temperatures and an attempt is made to assess the impact of the observed changes on the vehicle design. Results indicate that substantial improvements in performance are available for vehicles flying at up to Mach 4. ESA

N89-25970# Manchester Univ. (England). Dept. of Aeronautical Engineering.
AN INTRODUCTION TO THE PROBLEM OF AERODYNAMIC HEATING
D. I. A. Poll 1989 17 p
(AERO-Rept-8901; ETN-89-94956) Avail: NTIS HC A03/MF A01

Aerodynamic heat transfer to a body travelling at high speed is reviewed. The various sources of thermal energy which act upon the outer surface are identified and their relative importance is examined. Special consideration is given to the convective heat transfer from the body boundary layer. The complete boundary layer problem is described and an approximate solution method is presented. A generalized evaluation of the heating loads is developed and the results suggest that, for high speed devices flying at low altitude, the boundary layer convective heat load is the dominant term. This suggests that the surface temperatures and heat loads can only be evaluated by a simultaneous solution of the boundary layer flow and internal unsteady heat conduction problems. ESA

N89-25971# Manchester Univ. (England). Dept. of Aeronautical Engineering.
TRANSITION AND THE ATTAINMENT OF TURBULENT FLOW ON HYPERSONIC FLIGHT VEHICLES
D. I. A. Poll 1989 29 p
(AERO-Rept-8902; ETN-89-94957) Avail: NTIS HC A03/MF A01

Early attemps at correlating transition onset on complex, three-dimensional shapes are reviewed. These, together with Space Shuttle specific, rough surface, prediction methods are compared with the detailed picture of boundary-layer, transition front behavior deduced from the results of the Orbiter Flight Test program. The shortcomings of the existing methods are highlighted and the importance of tripping by isolated excrescences is demonstrated. Existing criteria for the prediction of roughness induced transition are considered. Improved relations are suggested and a link between roughness-induced transition and a commonly used engineering transition correlation parameter is established. ESA

N89-25972# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abteilung Trans-Ueberschall-Entwuresaerodynamik.
A LIFTING SURFACE METHOD FOR THE CALCULATION OF STEADY AND UNSTEADY, INCOMPRESSIBLE PROPELLER AERODYNAMICS Ph.D. Thesis - Technische Univ., Brunwsick
Juergen Schoene Jan. 1989 120 p In GERMAN; ENGLISH summary
(DFVLR-FB-89-04; ISSN-0171-1342; ETN-89-94980) Avail: NTIS HC A06/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 40

A lifting surface method for steady and unsteady propeller aerodynamics which allows the calculation of the lift distribution of single and counter-rotating propellers in axial onflow is described. The integral equation for lifting surfaces with time dependent lift distribution is derived, based on the acceleration potential of Prandtl. A solution method for this equation is developed. The lifting surfaces of the propeller blades are subdivided into panels. On a panel, doublets are located along a line. The doublet strength is developed into a Fourier series. A set of linear algebraic equations has to be solved. Calculations for wings, for single propellers with steady and unsteady lift distributions and for counter-rotating propellers are shown. ESA

N89-25973*# Continuum Dynamics, Inc., Princeton, NJ.
FEASIBILITY OF PREDICTING PERFORMANCE DEGRADATION OF AIRFOILS IN HEAVY RAIN Final Report
A. J. Bilanin, T. R. Quackenbush, and A. Feo Jun. 1989 44 p
(Contract NAS1-18302)
(NASA-CR-181842; NAS 1.26:181842; CDI-89-04) Avail: NTIS HC A03/MF A01 CSCL 01A

The heavy rain aerodynamic performance penalty program is detailed. This effort supported the design of a fullscale test program as well as examined the feasibility of estimating the degradation of performance of airfoils from first principles. The analytic efforts were supplemented by a droplet splashback test program in an attempt to observe the physics of impact and generation of ejecta. These tests demonstrated that the interaction of rain with an airfoil is a highly complex phenomenon and this interaction is not likely to be analyzed analytically with existing tools. Author

03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

N89-25974# National Transportation Safety Board, Washington, DC.
GENERAL AVIATION ACCIDENTS INVOLVING VISUAL FLIGHT RULES FLIGHT INTO INSTRUMENT METEOROLOGICAL CONDITIONS
8 Feb. 1989 39 p
(PB89-917001; NTSB/SR-89/01) Avail: NTIS HC A03/MF A01 CSCL 01C

A statistical compilation is presented of data from the National Transportation Safety Board's Aviation Accident Data System. The data includes 361 general aviation accidents that occurred between 1983 and early 1987. In all of these accidents, visual flight rule flight into instrument meteorological conditions was listed as a probable cause or a related factor. There were 276 fatal accidents which resulted in 583 fatalities. Ninety-four percent of the aircraft involved in these accidents were airplanes; the remainder were helicopters. Author

N89-25975# National Bureau of Standards, Gaithersburg, MD. Center for Fire Research.
IGNITION AND FLAME SPREAD MEASUREMENTS OF AIRCRAFT LINING MATERIALS
Margaret Harkleroad May 1988 64 p
(PB89-172886; NBSIR-88/3773) Avail: NTIS HC A04/MF A01 CSCL 01C

Experimental tests were conducted to study the lateral and upward flame spread behavior of eight aircraft lining materials. The results are tabulated in terms of parameters useful in predicting ignition and flame spread in the presence of an ignition source under exposure to an external radiant source. Experimental and derived results are graphically compared. Derived material properties related to and indicative of the propensity to support flame spread are presented. GRA

N89-25976# Boeing Co., Seattle, WA. Commercial Airplanes.
AIRPLANE TESTS OF ENHANCED EMERGENCY SMOKE VENTING Final Report
Elliott L. Maylor Mar. 1989 60 p
(Contract DTFA03-88-C-00056)
(D218N301; DOT/FAA/CT-89/9) Avail: NTIS HC A04/MF A01

This airplane test program evaluated the capability of certain air conditioning (environmental control) system modifications to enhance the venting of neutral or buoyant smoke that may be continuously injected into the passenger cabin during an inflight fire emergency. The program used a Boeing 757 airplane modified by adding an outflow valve in the forward upper lobe fuselage and changing to high-flow control valves in both air conditioning packs. Artificially generated smoke, neutral and with helium added to simulate buoyancy, was released at various passenger cabin locations. Data from the ground tests showed that an upper lobe outflow valve controls either neutral or buoyant smoke. Cruise/descent/land test results showed that neutral smoke can be controlled with either an upper or lower lobe outflow valve if the outflow valve and the smoke source are at the same end of the passenger cabin; this capability is not changed significantly by

a 30 percent increase to the current pack flow rate. The results also showed that maintaining pack flow while doors are open for passenger evacuation causes an undesirable increase in the rate of smoke spreading into the smoke free portions of the cabin.
Author

N89-25977*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYSIS OF SEVERE ATMOSPHERIC DISTURBANCES FROM AIRLINE FLIGHT RECORDS
R. C. Wingrove, R. E. Bach, Jr., and T. A. Schultz Jun. 1989 10 p Presented at the AGARD Flight Mechanics Panel Symposium-Flight in Adverse Environmental Conditions, Gol, Norway, 8-11 May 1989
(NASA-TM-102186; A-89111; NAS 1.15:102186) Avail: NTIS HC A02/MF A01 CSCL 01C

Advanced methods were developed to determine time varying winds and turbulence from digital flight data recorders carried aboard modern airliners. Analysis of several cases involving severe clear air turbulence encounters at cruise altitudes has shown that the aircraft encountered vortex arrays generated by destabilized wind shear layers above mountains or thunderstorms. A model was developed to identify the strength, size, and spacing of vortex arrays. This model is used to study the effects of severe wind hazards on operational safety for different types of aircraft. The study demonstrates that small remotely piloted vehicles and executive aircraft exhibit more violent behavior than do large airliners during encounters with high-altitude vortices. Analysis of digital flight data from the accident at Dallas/Ft. Worth in 1985 indicates that the aircraft encountered a microburst with rapidly changing winds embedded in a strong outflow near the ground. A multiple-vortex-ring model was developed to represent the microburst wind pattern. This model can be used in flight simulators to better understand the control problems in severe microburst encounters.
Author

N89-25978*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INVESTIGATION OF THE FLOW IN THE DIFFUSER SECTION OF THE NASA LEWIS ICING RESEARCH TUNNEL
Harold E. Addy, Jr. and Theo G. Keith, Jr. (Toledo Univ., OH.) Jan. 1989 13 p Presented at the 27th Aerospace Sciences Meeting, Reno, NV, 9-12 Jan. 1989; sponsored by AIAA Previously announced in IAA as A89-28455
(NASA-TM-102087; E-4849; NAS 1.15:102087; AIAA-89-0755) Avail: NTIS HC A03/MF A01 CSCL 01C

The flow in the diffuser section of the Icing Research Wind Tunnel at NASA Lewis Research Center is investigated using both tunnel calibration measurements and numerical simulation techniques. Local pressure and temperature measurements are made to establish velocity and temperature profiles in the diffuser of the tunnel. These profiles are compared with similar measurements made prior to renovating the equipment which generates the tunnel's icing cloud. This comparison indicates the manner in which this change affected the flow. The measured data were also compared with a numerical simulation of the flow to help understand how such changes may favorably alter the tunnel flow.
Author

N89-25979# Test Wing (4950th), Wright-Patterson AFB, OH. Aeronautical Systems Div.
EC-18B/BOEING 707 SMOKE VENTING FLIGHT TEST Final Report, Jan. - Jul. 1988
Daniel J. Mokris 27 Mar. 1989 75 p
(AD-A206601; Rept-4950/FTR-88-05-03) Avail: NTIS HC A04/MF A01 CSCL 01/2

This report presents the results of the smoke venting flight test on a USAF C-18, and a modified B-707 aircraft. A 3-in. x 4-in. smoke elimination valve (SEV) was installed in a metal window plug in a fuselage window forward of the wing's leading edge. The SEV consisted of a hinged flat plate that extended out into the slipstream. The local airflow accelerated around the plate, decreasing pressure in the area, and creating a draw that pulled smoke from the cabin of the aircraft. The objective of the test was to prove the feasibility of the SEV for venting smoke. The aircraft was instrumented with smoke density detecting light meters and a computerized data collection system. First, a baseline test of the aircraft's pressurization and air conditioning system was conducted. Then the SEV was opened to assess its smoke clearing capabilities. Smoke clearing time constants were developed to gauge the system's performance and ranged from 57 to 555 seconds, depending on the test condition. While the SEV did exhaust smoke, complex airflow within the cabin appeared to cause air stagnation in certain areas. This in turn forced the time constants to increase when the SEV was opened, a trend exactly opposite of what was expected. Recommendations were made to re-accomplish the tests using a more realistic scenario, repeat runs to increase reliability of data collected, and use some means to visualize local flow patterns in certain key areas around the cabin.
GRA

N89-25980*# Miami Univ., Coral Gables, FL. Dept. of Management Science.
HUMAN FACTORS OF ADVANCED TECHNOLOGY (GLASS COCKPIT) TRANSPORT AIRCRAFT
Earl L. Wiener Jun. 1989 222 p
(Contract NCC2-377)
(NASA-CR-177528; NAS 1.26:177528) Avail: NTIS HC A10/MF A01 CSCL 01C

A three-year study of airline crews at two U.S. airlines who were flying an advanced technology aircraft, the Boeing 757 is discussed. The opinions and experiences of these pilots as they view the advanced, automated features of this aircraft, and contrast them with previous models they have flown are discussed. Training for advanced automation; (2) cockpit errors and error reduction; (3) management of cockpit workload; and (4) general attitudes toward cockpit automation are emphasized. The limitations of the air traffic control (ATC) system on the ability to utilize the advanced features of the new aircraft are discussed. In general the pilots are enthusiastic about flying an advanced technology aircraft, but they express mixed feelings about the impact of automation on workload, crew errors, and ability to manage the flight.
Author

N89-25981*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CONTROLLER EVALUATIONS OF THE DESCENT ADVISOR AUTOMATION AID
Leonard Tobias, Uwe Volckers (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.), and Heinz Erzberger Jun. 1989 13 p Presented at the AIAA American Control Conference, Pittsburgh, PA, Jun. 1989
(NASA-TM-102197; A-89150; NAS 1.15:102197) Avail: NTIS HC A03/MF A01 CSCL 01C

An automation aid to assist air traffic controllers in efficiently spacing traffic and meeting arrival times at a fix has been developed at NASA Ames Research Center. The automation aid, referred to as the descent advisor (DA), is based on accurate models of aircraft performance and weather conditions. The DA generates suggested clearances, including both top-of-descent point and speed profile data, for one or more aircraft in order to achieve specific time or distance separation objectives. The DA algorithm is interfaced with a mouse-based, menu-driven controller display that allows the air traffic controller to interactively use its accurate predictive capability to resolve conflicts and issue advisories to arrival aircraft. This paper focuses on operational issues concerning the utilization of the DA, specifically, how the DA can be used for prediction, intrail spacing, and metering. In order to evaluate the DA, a real time simulation was conducted using both current and retired controller subjects. Controllers operated in teams of two, as they do in the present environment; issues of training and team interaction will be discussed. Evaluations by controllers indicated considerable enthusiasm for the DA aid, and provided specific recommendations for using the tool effectively.
Author

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

N89-25982# National Aerospace Lab., Tokyo (Japan).
STATISTICAL CHARACTERISTICS OF MEASUREMENT NOISE INCLUDED IN DME OUTPUT. COMPATIBILITY CHECK WITH DOPLER RADAR OUTPUT
Takatsugu Ono Feb. 1988 16 p In JAPANESE; ENGLISH summary
(NAL-TR-961; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

Statistical characteristics of measurement noise included in Distance Measuring Equipment (DME) output were investigated by checking their compatibility with Doppler Radar output. After integration, Doppler Radar measurement gives an estimated horizontal range distance. The estimated range was compared with the measurements of two independent DME systems and yielded two measurement residuals. Each residual includes the measurement noises both of the Doppler Radar system and of the DME system. It was shown that by estimating covariance functions of these residuals, the statistical characteristics of noises which contaminated DME and Doppler Radar measurements could be separately identified. Using flight test data of NAL's VSRA, a hardware component of the DME system that had possibly introduced adverse nose into output measurements was detected. Statistical characteristics of DME measurement noise were represented by the estimated correlation functions and power spectral density functions. Author

N89-25983# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
PLANNING FOR A VISUAL NAVIGATION SYSTEM [PLANEJAMENTO PARA UM SISTEMA DE NAVEGACAO VISUAL]
C. A. MarquesNogueira and Walter Rodrigues Jun. 1988 8 p In PORTUGUESE; ENGLISH summary Presented at the 3rd Latin American Conference on Automation, Vina del Mar, Chile, 3-7 Oct. 1988
(INPE-4616-PRE/1339) Avail: NTIS HC A02/MF A01

The introduction of artificial intelligence techniques permits more flexibility in the control of autonomous navigation systems. The Visual Navigation System (SNV) adopts a mixed representation of the environment topology which uses the techniques of region growth and division in convex poligons. How the planning uses this representation is shown and a strategy to divide rooms in convex poligons is presented. Author

N89-25984# Federal Aviation Administration, Atlantic City, NJ.
HELIPORT IDENTIFICATION BEACON
Paul H. Jones Apr. 1989 14 p
(DOT/FAA/CT-TN89/31) Avail: NTIS HC A03/MF A01

The International Civil Aviation Organization (ICAO) has proposed the adoption of a standard international heliport beacon. This beacon consists of a white strobe light coded to display a sequence of four flashes that signify the Morse code letter H. For evaluation purposes, the proposed strobe beacon was compared to the United States standard three-color rotating beacon. Pilots completed post-flight questionnaires after viewing both beacons. Without any clear-cut choice as to which beacon was the best, pilot responses indicated that both beacons provide adequate guidance in locating a heliport. From these results, there does not appear to be reasonable cause for opposing adoption of the proposed strobe beacon as an ICAO standard. Furthermore, there does not appear to be any compelling reason to change the present United States standard for heliport identification beacons at this time. Author

N89-25985# Federal Aviation Administration, Atlantic City, NJ.
EVALUATION OF A PROJECTION ALGORITHM FOR THE STEREOGRAPHIC REPRESENTATION OF AIRCRAFT IN AN AIR TRAFFIC CONTROL SYSTEM
Robert G. Mulholland Apr. 1989 27 p
(DOT/FAA/CT-TN89/20) Avail: NTIS HC A03/MF A01

In an air traffic control system such as the National Airspace System (NAS) horizontal control is effected from a ground facility through the separation of aircraft in at least one of the dimensions of latitude and longitude. Ideally, these dimensions are obtained indirectly in real time by means of a projection algorithm that maps raw surveillance information into the stereographic representation of aircraft latitude and longitude on a plane surface. In practice, there is always some processing delay and some difference between the algorithm output and the actual stereographic representation of aircraft position. In addition, the accuracy is affected by the orientation of the plane relative to the control jurisdiction of the facility. While the projection algorithm currently employed in NAS is capable of timely delivery of output due to its structural simplicity, it cannot meet the accuracy requirement of the Advanced Automation System. The accuracy of a simple modification of the NAS algorithm that does meet this requirement is evaluated by means of a technique that avoids determination of the geometric relationship of the plane and the control jurisdiction. Author

N89-25986# Federal Aviation Administration, Atlantic City, NJ. Technical Center.
CONTROLLER EVALUATION OF INITIAL DATA LINK AIR TRAFFIC CONTROL SERVICES. VOLUME 2: MINI STUDY 2 Final Report
Nicholas J. Talotta, Clark Shingledecker, Thomas Zurinskas, Karol Kerns, Preston Cratch (Mitre Corp., Atlantic City, NJ.), and Henry R. Marek Mar. 1989 73 p
(DOT/FAA/CT-89/14-Vol-2) Avail: NTIS HC A04/MF A01

The results of Mini Study 2 are given. This Mini Study was conducted at the Federal Aviation Administration (FAA) Technical Center utilizing the Data Link test bed. Initial Data Link air traffic control services were evaluated under part task simulation conditions in order to identify service delivery methods which optimize controller acceptance, performance, and workload. Author

N89-25987*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A NOVEL MULTISTAGE ESTIMATION OF THE SIGNAL PARAMETERS OF A POSSIBLY DATA-MODULATED SINUSOID UNDER VERY HIGH DYNAMICS
Rajendra Kumar 1 May 1989 48 p Prepared in cooperation with Air Force Armament L ab., Eglin AFB, FL
(Contract NAS7-918)
(NASA-CR-183092; JPL-Publ-89-11; NAS 1.26:183092) Avail: NTIS HC A03/MF A01 CSCL 17G

A novel multistage estimation scheme is presented for estimating the parameters of a received carrier signal possibly phase-modulated by unknown data, and experiencing very high Doppler, Doppler rate, etc. Such a situation arises, for example, in the case of Global Positioning Systems (GPS) where the signal parameters are directly related to the position, velocity, acceleration and jerk of the GPS receiver. In the proposed multistage scheme, the first stage estimator operates as a coarse estimator resulting in higher rms estimation errors but with a relatively small probability of the frequency estimation error exceeding one-half of the sampling frequency (an event termed cycle slip). The second state of the estimator operates on the error signal available from the first stage, refining the overall estimates, and in the process also reduces the number of cycle slips. The first stage algorithm is selected to be a modified least squares algorithm operating upon the differential signal model and referred to as differential least squares. This estimation stage provides relatively coarse estimates of the frequency and its derivatives. The second algorithm is simply an extended Kalman filter which also yields the estimate of the phase along with a more refined estimate of frequency as well. A

major advantage of the proposed algorithm is a reduction in the threshold on received carrier power-to-noise power spectral density ratio as compared to the threshold achievable by either of these algorithms alone. In fact, it appears from the simulations that for the case of an unmodulated carrier, the proposed scheme achieves the same threshold as for an almost exact and computationally intensive implementation of the maximum likelihood estimator.
Author

N89-25988# Army Engineer Topographic Labs., Fort Belvoir, VA.
TARGET LOCATION ERRORS DERIVED FROM A HYPOTHETICAL TARGET TRACKING SYSTEM Technical Report, Jun. - Sep. 1987
Michael A. Crombie Feb. 1989 120 p
(AD-A206696; ETL-0531) Avail: NTIS HC A06/MF A01
CSCL 17/11

An error analysis of a hypothetical target tracking system developed around an ongoing Real-Time Attitude (RTA) project at the Space Programs Laboratory was performed at the U.S. Army Engineer Topographic Laboratories. An extensive set of tables of target errors was developed as a function of a variety of collection geometries and system component random errors. The target tracking system includes RTA, a real-time positioning capability, an automatic target sensor, and a slant range measuring device. The system components were characterized in the study by their expected random errors. For example, the real-time positioning capability in this study reflects the expected range of Global Positioning System errors.
GRA

N89-25989# Naval Training Systems Center, Orlando, FL.
MICROCOMPUTER SYSTEM INTEGRATION FOR AIR CONTROL TRAINING Special Report, Jan. - Dec. 1987
Cheryl J. Hamel, David Kotick, and Mark Layton 25 Jan. 1989 45 p
(AD-A207202; NTSC-SR-89-01) Avail: NTIS HC A03/MF A01
CSCL 05/6

The research was designed to demonstrate a microcomputer system configuration for air control training. The objective of the research was to systemmatically integrate off-the-shelf components of microcomputer and microprocessor technology into a model prototype system for air control training. A subgoal was to examine voice input/output technology for its potential use in a microcomputer-based air control training system. The microcomputer system Personal Computer/Naval Tactical Data System (PC/NTDS) used for Air Intercept Control (AIC) training is presented. It describes the automated speech recognition and speech generation technology chosen to interface with the system. Data collected using several subjects who completed AIC lessons using the system are summarized. Advantages and disadvantages of using voice input/output technology for air control training are discussed, and recommendations for future research using the microcomputer testbed are provided.
GRA

N89-26495*# Rockwell International Science Center, Thousand Oaks, CA.
SENSOR SYSTEMS TESTBED FOR TELEROBOTIC NAVIGATION
A. W. Thiele, D. E. Gjellum, R. H. Rattner, and D. Manouchehri (Rockwell International Corp., Downey, CA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 19-21 (For primary document see N89-26492 20-63)
(Contract NAS9-17365)
Avail: NTIS HC A18/MF A01 CSCL 17G

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics.* For land transportation vehicles see *85 Urban Technology and Transportation.*

N89-25990# National Aerospace Lab., Tokyo (Japan).
LONGITUDINAL NONLINEAR AERODYNAMIC MODEL FORM FOR USB-STOL AIRCRAFT
Sep. 1988 52 p In JAPANESE; ENGLISH summary
(NAL-TR-995; ISSN-0389-4010) Avail: NTIS HC A04/MF A01

A longitudinal nonlinear aerodynamic model form for USB-STOL aircraft was prepared. The static and dynamic parts of the model form were drawn separately. The static model form was then verified by fitting it to wind tunnel test data of the NAL-STOL experimental airplane ASUKA. For the dynamic form, three types of model form were proposed as candidates. The candidates differ from each other in the method of modeling the lag of downwash: In the first model the lag is simulated precisely, in the second model it is approximated from the first lag, and in the third model, the lag is neglected. A comparison of the results of dynamic flight simulation with these three models comes to the conclusion that the second model is the most appropriate for parameter identification from flight test data.
Author

N89-25991 Department of the Air Force, Washington, DC.
AIRCRAFT ENGINE OUTER DUCT MOUNTING DEVICE Patent
Ronald E. Quinn, inventor (to Air Force) 13 Dec. 1988 4 p
Filed 17 Jul. 1987
(AD-D013988; US-Patent-4,790,137; US-Patent-Appl-SN-074802)
Avail: US Patent and Trademark Office CSCL 21/5

The invention comprises a mounting assembly for supporting the turbine outer casing duct adjacent to the turbine frame. Multiple support posts are mounted to the turbine frame and roller means are rotatably attached to each support post. The roller means are aligned to rotate on a contact surface of the outer casing duct. Movement of the rollers on the contact surface is caused by the relative movement of the turbine frame and outer casing duct.
GRA

N89-25992*# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Mechanical Engineering.
AN INVESTIGATION OF NEW METHODS FOR ESTIMATING PARAMETER SENSITIVITIES Final Report
Todd J. Beltracchi and Gary A. Gabriele Washington Aug. 1989 137 p
(Grant NAG1-752)
(NASA-CR-4245; NAS 1.26:4245) Avail: NTIS HC A07/MF A01 CSCL 01C

The method proposed for estimating sensitivity derivatives is based on the Recursive Quadratic Programming (RQP) method and in conjunction a differencing formula to produce estimates of the sensitivities. This method is compared to existing methods and is shown to be very competitive in terms of the number of function evaluations required. In terms of accuracy, the method is shown to be equivalent to a modified version of the Kuhn-Tucker method, where the Hessian of the Lagrangian is estimated using the BFS method employed by the RQP algorithm. Initial testing on a test set with known sensitivities demonstrates that the method can accurately calculate the parameter sensitivity.
Author

N89-25993*# Ohio State Univ., Columbus. Dept. of Electrical Engineering.
ANALYSIS OF MODIFIED SMI METHOD FOR ADAPTIVE ARRAY WEIGHT CONTROL M.S. Thesis
Ronald Louis Dilsavor 1989 99 p
(Grant NAG3-536)
(NASA-CR-185493; NAS 1.26:185493) Avail: NTIS HC A05/MF A01 CSCL 01C

An adaptive array is used to receive a desired signal in the

presence of weak interference signals which need to be suppressed. A modified sample matrix inversion (SMI) algorithm controls the array weights. The modification leads to increased interference suppression by subtracting a fraction of the noise power from the diagonal elements of the covariance matrix. The modified algorithm maximizes an intuitive power ratio criterion. The expected values and variances of the array weights, output powers, and power ratios as functions of the fraction and the number of snapshots are found and compared to computer simulation and real experimental array performance. Reduced-rank covariance approximations and errors in the estimated covariance are also described. Author

N89-25994# Federal Aviation Administration, Atlantic City, NJ.
FUEL CONTAINMENT SYSTEM CONCEPT TO REDUCE SPILLAGE
Robert F. Salmon Jun. 1989 28 p
(DOT/FAA/CT-TN89/22) Avail: NTIS HC A03/MF A01

The purpose is to describe a new concept in aircraft fuel tank design to reduce the spillage from an aircraft fuel tank which has been ruptured during what could be considered a survivable crash. The time element is very critical for survival after a crash. By reducing the amount of fuel spilled during the first minute after the aircraft comes to rest, the probability of passenger survival can be greatly enhanced. Author

N89-25995# Nondestructive Testing Information Analysis Center, San Antonio, TX. Dept. of Mechanical Sciences.
NONDESTRUCTIVE QUALIFICATION OF UH-1 REPLACEMENT PARTS: COMPLETION ENHANCEMENT Final Report, Sep. 1986 - Dec. 1987
Roger L. Bessey 7 Nov. 1988 5 p
(Contract DLA900-84-C-0910; SwRI Proj. 17-7958-832)
(AD-A206674) Avail: NTIS HC A02/MF A01 CSCL 01/3

A listing of data packages completed on this program and breakout/feasibility studies which were performed, are presented. GRA

N89-25996# Virginia Polytechnic Inst. and State Univ., Blacksburg.
RELAXATION OSCILLATIONS IN AIRCRAFT CRUISE-DASH OPTIMIZATION Technical Paper Aug. 1986 - Mar. 1988
U. J. Shankar, H. J. Kelley (RCA Astro-Electronics Div., Princeton, NJ.), and E. M. Cliff 15 Aug. 1988 35 p
(Contract F08635-86-K-0390)
(AD-A206722; AFATL-TP-89-03) Avail: NTIS HC A03/MF A01 CSCL 01/1

Periodic solutions in energy approximation are sought for aircraft optimal cruise-dash problems. The cost functional is the weighted sum of the time taken and the fuel used average over the cycle. It is known from previous work that in energy-state approximation, relaxed-steady-state control gives lower costs than the steady-state solution. However, this control is not implementable. Higher approximations to this are sought via averaging oscillations. The fast dynamics (path angle/altitude/throttle/lift coefficient) is modeled in terms of periodic solutions in a boundary-layer-like motion which does not die out but moves along with the progression of the slow state energy. This is shown not to help the situation. A better approximation in terms of relaxation oscillations is proposed. Unlike earlier models, the energy is allowed to vary. However, the net change in energy per cycle is zero. Fast, constant-energy climbs and descents and slow energy transitions are spliced together in zeroth order approximation to obtain the periodic solutions. The energies in question are determined as part of the problem. This technique is shown to produce a more practical solution, but still needs improvement for practical application. GRA

N89-25997# Naval Ship Research and Development Center, Bethesda, MD. Aviation Dept.
TIPJET VTOL UAV (VERTICAL TAKEOFF AND LANDING/UNMANNED AERIAL VEHICLE) SUMMARY. VOLUME 1: A 1200 POUND TIPJET VTOL UNMANNED AERIAL VEHICLE. PART 1: CONCEPTUAL DESIGN STUDY OF A 1200-POUND VEHICLE Interim Report, Apr. - Dec. 1988
Kenneth R. Reader, Jane S. Abramson, Alan W. Schwartz, and James C. Biggers Jan. 1989 80 p
(AD-A206738; DTRC/AD-89/01) Avail: NTIS HC A05/MF A01 CSCL 01/3

A new concept is developed for an Unmanned Aerial Vehicle (UAV) configured with a tip-jet driven, two-bladed, stoppable rotor and circulation control airfoils. The conceptual design of the Tipjet Vertical Takeoff and Landing (VTOL) UAV is presented, and vehicle performance is evaluated for three mid-range UAV Navy missions: Tactical Reconnaissance, Over-the-Horizon Targeting, and Combat Support Reconnaissance. Vehicle performance predictions are presented for hover and low-speed, rotary-wing flight, for conversion between rotary-wing and fixed-wing flight, and for fixed-wing flight. Requirements for shipboard support of the vehicle are outlined. Mission specific equipment is described including size, weight, and power requirements. Standard design methods are applied to conduct a detailed mission performance analysis for the conceptual design. The analysis results indicate that the 1200-lb Tipjet VTOL UAV is a viable candidate vehicle for the specified missions. Moreover, the concept is directly applicable to much larger UAVs that will greatly enhance naval warfare capabilities. Part 1 of Volume 1 presents the conceptual design for the Tipjet VTOL UAV along with vehicle performance analysis for the designed missions. GRA

N89-25998# General Accounting Office, Washington, DC. National Security and International Affairs Div.
STRATEGIC BOMBERS: B-1B COST AND PERFORMANCE REMAIN UNCERTAIN
3 Feb. 1989 60 p
(AD-A206751; GAO/NSIAD-89-55) Avail: NTIS HC A04/MF A01 CSCL 01/3

Early in 1987 The General Accounting Office testified on the B-1B bomber program before the House and Senate Committees on Armed Services. It identified B-1B development deficiencies during the testimonies, and the Chairmen requested that GAO continue to monitor the program. This report updates and assesses the progress of the B-1B program since 1987 and presents other related issues. On October 2, 1981, the President announced his decision to develop and deploy 100 B-1Bs. In selecting the B-1B, DOD believed that the technology, cost, and schedule risks would be low because of the experience gained from the canceled B-1A program. On January 18, 1982, the President certified to the Congress that the B-1B would have an initial operational capability during 1986 and that the development and acquisition baseline cost of B-1B fleet would not exceed $20.5 billion ($27.8 billion escalated dollars). However, to field the B-1B in just 5 years, the program would feature highly concurrent full-scale development, production, and testing schedules. GRA

N89-25999# Texas Univ., Austin. Dept. of Aerospace Engineering and Engineering Mechanics.
TIME-TO-GO PREDICTION FOR A HOMING MISSILE BASED ON MINIMUM-TIME TRAJECTORIES Technical Report, Aug. 1987 - Sep. 1988
David G. Hull and Jerry J. Radke Sep. 1988 8 p Previously announced in IAA as A88-50174
(Contract F08635-87-K-0417)
(AD-A206764; AFATL-TR-89-09) Avail: NTIS HC A02/MF A01 CSCL 16/2

In two dimensions the trajectory of a constant velocity missile which intercepts a zero-acceleration target and which minimizes the weighted sum of the final time and the integral of the missile normal acceleration squared is derived. The launch angle of the missile is arbitrarily prescribed. The optimal control involves elliptic functions and requires the numerical solution of two non-linear

algebraic equations for its calculation. This procedure is used to calculate the time-to-go in a six degree of freedom simulation in which the target performs maneuvers. The current missile velocity is projected on the plane of the line of sight vector and the target vector, and the time required to perform the two dimensional intercept is calculated and used as the time-to-go for the linear quadratic guidance law of the missile. Results show substantial improvement relative to the range-over-closing speed method of computing time-to-go. GRA

N89-26000# Federal Aviation Administration, Washington, DC. Advanced System Design Service.
FAA ROTORCRAFT RESEARCH, ENGINEERING AND DEVELOPMENT BIBLIOGRAPHY, 1962-1988: SUPPLEMENT
Robert D. Smith Mar. 1989 103 p
(AD-A207162; AD-E501097; DOT/FAA/DS-89/03) Avail: NTIS HC A06/MF A01 CSCL 01/3

This bibliography of FAA rotorcraft reports published from 1962 to 1988 is a supplement to an earlier bibliography. Both bibliographies are limited to documents in which the research, engineering, and development elements of the FAA were involved as sponsors, participants, or authors. This bibliography contains abstracts on 53 technical reports. The indexes in this document address these 53 reports as well as the 133 reports in the earlier bibliography (FAA/PM-86/47). GRA

N89-26001 Technische Univ., Delft (Netherlands).
DEVELOPMENT AND APPLICATION OF A COMPUTER-BASED SYSTEM FOR CONCEPTUAL AIRCRAFT DESIGN Ph.D. Thesis
Cornelis Bil 1988 267 p
(ETN-89-94886) Copyright Avail: Delft Univ. Press, Stevinweg 1, 2628 CN Delft, Netherlands

A system for computer aided conceptual aircraft design was developed and implemented. Although this system is intended for design education and research in a university environment, it incorporates basic features and capabilities that are considered as representative for computer aided engineering applications in industrial practice. Although an acceptable, optimum design configuration is obtained, verification and validation remains difficult. This is inherent to the use of conceptual design methods. The analysis methods currently implemented in the program library are generally referred to as class 1 methods. They are usually based on statistical/empirical considerations and are generally quite suitable for obtaining absolute answers with very little input information. However, caution must be taken when using these methods in automated design. ESA

06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

N89-26002# Krug International, San Antonio, TX. Technology Services Div.
WAVELENGTH-DEPENDENT AND -INDEPENDENT EFFECTS OF VEILING GLARE ON THE VISIBILITY OF HEAD-UP DISPLAY (HUD) SYMBOLOGY Final Report, Sep. 1986 - Jan. 1988
Denise C. Varner, Robert M. Cartiedge, W. R. Elliott, III, Arthur R. Menendez, and Roxie Carrier Sep. 1988 24 p
(Contract F33615-84-C-0600)
(AD-A206905; USAFSAM-TR-88-15) Avail: NTIS HC A03/MF A01 CSCL 09/5

We have measured the effects of laser glare-source wavelength on the visibility of Head-Up Display (HUD) symbology. Most of the effects are due to the wavelength dependence of human illuminance sensitivity. When the human visibility function is taken into account, the magnitude of the wavelength dependence is reduced by a factor of 4.2. A second effect is a wavelength-independent effect in subjects. This second effect is directly correlated with subject age. The remaining (small) variation may be due to chromatic contrast sensitivity. GRA

07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

N89-26003*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ON THE APPLICATIONS OF ALGEBRAIC GRID GENERATION METHODS BASED ON TRANSFINITE INTERPOLATION
Hung Lee Nguyen Jun. 1989 25 p
(NASA-TM-102095; E-4778; NAS 1.15:102095) Avail: NTIS HC A03/MF A01 CSCL 21E

Algebraic grid generation methods based on transfinite interpolation called the two-boundary and four-boundary methods are applied for generating grids with highly complex boundaries. These methods yield grid point distributions that allow for accurate application to regions of sharp gradients in the physical domain or time-dependent problems with small length scale phenomena. Algebraic grids are derived using the two-boundary and four-boundary methods for applications in both two- and three-dimensional domains. Grids are developed for distinctly different geometrical problems and the two-boundary and four-boundary methods are demonstrated to be applicable to a wide class of geometries. Author

N89-26004*# Sverdrup Technology, Inc., Cleveland, OH.
TURBOFAN ENGINE CONTROL SYSTEM DESIGN USING THE LQG/LTR METHODOLOGY Final Report
Sanjay Garg Jun. 1989 24 p Presented at the American Control Conference, Pittsburgh, PA, 21-23 Jun. 1989; sponsored by American Automatic Control Council
(Contract NAS3-25266)
(NASA-CR-182303; E-4765; NAS 1.26:182303) Avail: NTIS HC A03/MF A01 CSCL 21E

Application of the Linear-Quadratic-Gaussian with Loop-Transfer-Recovery methodology to design of a control system for a simplified turbofan engine model is considered. The importance of properly scaling the plant to achieve the desired Target-Feedback-Loop is emphasized. The steps involved in the application of the methodology are discussed via an example, and evaluation results are presented for a reduced-order compensator. The effect of scaling the plant on the stability robustness evaluation of the closed-loop system is studied in detail. Author

N89-26005# United Technologies Research Center, East Hartford, CT.
THREE DIMENSIONAL FLOW AND TEMPERATURE PROFILE ATTENUATION IN AN AXIAL FLOW TURBINE Final Report, 15 Dec. 1985 - 15 Mar. 1989
David H. Joslyn and Robert P. Dring 15 Mar. 1989 136 p
(Contract F49620-86-C-0020)
(AD-A206736; AFOSR-89-0439TR) Avail: NTIS HC A07/MF A01 CSCL 21/5

While strongly three dimensional and highly unsteady nature of the flow in axial turbines has, until recently, defied in-depth analysis, the benefits that can be realized from an improved capability to predict the aerodynamics and heat transfer in turbines are numerous. These benefits include improved performance through higher efficiency, higher thrust-to-weight ratio through higher turbine inlet temperature, and improved durability through more precise predictions of local heat load. This program was particularly interested in the aerodynamic mechanisms affecting

attenuation of a radial temperature profile in the flow as it passed through the turbine. The radial temperature profile in the flow exiting a combustor and entering a turbine can range from compressor exit temperature (approx = 1100 F) near the hub and tip end walls to a maximum (as high as 3200 F) in the midspan region. The heat load at any location on the turbine airfoils or end walls depends strongly on the local gas temperature at that location; hence the mixing, or attenuation, of the inlet temperature profile is of critical importance. This program has advanced the state-of-the-art by providing: (1) an exhaustive aerodynamic data base for the three dimensional flow in a large scale axial turbine; (2) an exhaustive data base documenting the mixing of a simulated combustor exit temperature profile as it passed through the turbine; and (3) an assessment of state of the art three dimensional time accurate, Navier-Stokes prediction of the flow in the turbine stage. GRA

N89-26006# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH. Turbine Engine Div.
TWO AXIAL COMPRESSOR DESIGNS FOR A STAGE MATCHING INVESTIGATION Final Interim Report, 1 Jan. - 30 Sep. 1988
C. Herbert Law Mar. 1989 281 p
(AD-A206951; AFWAL-TR-89-2005) Avail: NTIS HC A13/MF A01 CSCL 13/11

The design of two single-stage axial-flow compressors for a stage matching investigation are described. The purpose of the investigation is to develop a data base and design techniques necessary to match supersonic blade rows in turbomachinery compression systems. Two compressor designs are required to investigate both fan-type and core-type compression systems, since each configuration has unique aerodynamic and performance characteristics. The latest state-of-the-art aerodynamic and mechanical design techniques were used to design two supersonic stages to be tested in an environment typical of the second-stage of an advanced military fan and an advanced military core compressor. This report presents the results of the detailed aerodynamic design of the two compressor stages. GRA

N89-26007*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ENGINEERING STUDY OF THE ROTARY-VEE ENGINE CONCEPT
Edward A. Willis, Timothy A. Bartrand (Sverdrup Technology, Inc., Cleveland, OH.), and John E. Beard Mar. 1989 38 p Presented at the Annual Congress and Exposition, Detroit, MI, 27 Feb. - 3 Mar. 1989; sponsored by Society of Automotive Engineers
(NASA-TM-101995; E-4698; NAS 1.15:101995; SAE-89-0332)
Avail: NTIS HC A03/MF A01 CSCL 21E

The applicable thermodynamic cycle and performance considerations when the rotary-vee mechanism is used as an internal combustion (I.C.) heat engine are reviewed. Included is a simplified kinematic analysis and studies of the effects of design parameters on the critical pressures, torques and parasitic losses. A discussion of the principal findings is presented. Author

N89-26008*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AERONAUTICAL APPLICATIONS OF HIGH-TEMPERATURE SUPERCONDUCTORS
George E. Turney, Roger W. Luidens, Kenneth Uherka, and John Hull (Argonne National Lab., IL.) Aug. 1989 15 p Presented at the Aircraft Design, Systems and Operations Conference, Seattle, WA, 31 Jul. - 2 Aug. 1989; sponsored in part by AIAA, AHS, and ASEE
(NASA-TM-102311; E-4951; NAS 1.15:102311) Avail: NTIS HC A03/MF A01 CSCL 21E

The successful development of high-temperature superconductors (HTS) could have a major impact on future aeronautical propulsion and aeronautical flight vehicle systems. A preliminary examination of the potential application of HTS for aeronautics indicates that significant benefits may be realized through the development and implementation of these newly discovered materials. Apllications of high-temperature superconductors (currently substantiated at 95 K) were envisioned for several classes of aeronautical systems, including subsonic and supersonic transports, hypersonic aircraft, V/STOL aircraft, rotorcraft, and solar, microwave and laser powered aircraft. Introduced and described are the particular applications and potential benefits of high-temperature superconductors as related to aeronautics and/or aeronautical systems. Author

08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

N89-26009*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTEGRATED FLIGHT/PROPULSION CONTROL SYSTEM DESIGN BASED ON A CENTRALIZED APPROACH
Sanjay Garg, Duane L. Mattern (Sverdrup Technology, Inc., Cleveland, OH.), and Randy E. Bullard 1989 41 p Presented at the Guidance, Navigation and Control Conference, Boston, MA, 14-16 Aug. 1989; sponsored by the AIAA
(NASA-TM-102137; E-4860; NAS 1.15:102137; AIAA-89-3520)
Avail: NTIS HC A03/MF A01 CSCL 01C

An integrated flight/propulsion control system design is presented for the piloted longitudinal landing task with a modern, statically unstable, fighter aircraft. A centralized compensator based on the Linear Quadratic Gaussian/Loop Transfer Recovery methodology is first obtained to satisfy the feedback loop performance and robustness specificiations. This high-order centralized compensator is then partitioned into airframe and engine sub-controllers based on modal controllability/observability for the compensator modes. The order of the sub-controllers is then reduced using internally-balanced realization techniques and the sub-controllers are simplified by neglecting the insignificant feedbacks. These sub-controllers have the advantage that they can be implemented as separate controllers on the airframe and the engine while still retaining the important performance and stability characteristics of the full-order centralized compensator. Command prefilters are then designed for the closed-loop system with the simplified sub-controllers to obtain the desired system response to airframe and engine command inputs, and the overall system performance evaluation results are presented. Author

N89-26010*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLUTTER SUPPRESSION CONTROL LAW SYNTHESIS FOR THE ACTIVE FLEXIBLE WING MODEL
Vivek Mukhopadhyay (Planning Research Corp., Hampton, VA.), Boyd Perry, III, and Thomas E. Noll May 1989 9 p Presented at the European Forum on Aeroelasticity and Structural Dynamics, Aachen, Fed. Republic of Germany, 17-19 Apr. 1989
(NASA-TM-101584; NAS 1.15:101584) Avail: NTIS HC A02/MF A01 CSCL 01C

The Active Flexible Wing Project is a collaborative effort between the NASA Langley Research Center and Rockwell International. The objectives are the validation of methodologies associated with mathematical modeling, flutter suppression control law development and digital implementation of the control system for application to flexible aircraft. A flutter suppression control law synthesis for this project is described. The state-space mathematical model used for the synthesis included ten flexible modes, four control surface modes and rational function approximation of the doublet-lattice unsteady aerodynamics. The design steps involved developing the full-order optimal control laws, reducing the order of the control law, and optimizing the reduced-order control law in both the continuous and the discrete domains to minimize stochastic response. System robustness was improved using singular value constraints. An 8th order robust

control law was designed to increase the symmetric flutter dynamic pressure by 100 percent. Preliminary results are provided and experiences gained are discussed. Author

N89-26011*# Boeing Commercial Airplane Co., Seattle, WA.
DESCENT STRATEGY COMPARISONS FOR TNAV-EQUIPPED AIRCRAFT UNDER AIRPLANE-PREFERRED OPERATING CONDITIONS Final Report
K. H. Izumi Washington Aug. 1989 41 p
(Contract NAS1-18027)
(NASA-CR-4248; NAS 1.26:4248) Avail: NTIS HC A03/MF A01 CSCL 01C

Three 4-D descent strategies were evaluated which were employed by TNAV-equipped aircraft in an advanced metering air traffic control environment. The Flow Management Evaluation Model (FMEM) was used to assess performance using three criteria when traffic enters the simulation under preferred cruise operating conditions (altitude and speed): throughput, fuel usage, and conflict probability. In comparison to an evaluation previously performed under NASA contract, the current analysis indicates that the optimal descent strategy is preferred over the clean-idle and constant descent angle (CFPA) strategies when all three criteria are considered. Author

N89-26012# Virginia Polytechnic Inst. and State Univ., Blacksburg. Interdisciplinary Center for Applied Mathematics.
STATE SPACE MODELS FOR AEROELASTIC AND VISCOELASTIC SYSTEMS Technical Report, 1 Jan. - 31 Dec. 1988
T. L. Herdman 15 Feb. 1989 5 p
(Grant AF-AFOSR-0074-88; AF Proj. 2304)
(AD-A207092; AFOSR-89-0380TR) Avail: NTIS HC A02/MF A01 CSCL 01/1

Dynamic modeling of various aeroelastic control systems require at some point in the derivation of the model an application of Soehngen's inversion formula for finite Hilbert transforms to obtain a desired representation for the solution of the airfoil equation. Conditions on initial data to guarantee well-posedness of the resulting model equations must be matched with those needed to justify the validity of the inversion formula. It is shown that this compatibility can be achieved by assuming that the circulation history belongs to a weighted L2 space. The resulting state space formulation provides a suitable setting for control design for the aeroelastic system. GRA

N89-26013*# Systems Technology, Inc., Hawthorne, CA.
ADVANCED PILOTED AIRCRAFT FLIGHT CONTROL SYSTEM DESIGN METHODOLOGY. VOLUME 1: KNOWLEDGE BASE Final Report
Duane T. McRuer and Thomas T. Myers Oct. 1988 285 p
(Contract NAS1-17987)
(NASA-CR-181726-Vol-1; NAS 1.26:181726-Vol-1; STI-TR-1228-1) Avail: NTIS HC A13/MF A01 CSCL 01C

The development of a comprehensive and electric methodology for conceptual and preliminary design of flight control systems is presented and illustrated. The methodology is focused on the design stages starting with the layout of system requirements and ending when some viable competing system architectures (feedback control structures) are defined. The approach is centered on the human pilot and the aircraft as both the sources of, and the keys to the solution of, many flight control problems. The methodology relies heavily on computational procedures which are highly interactive with the design engineer. To maximize effectiveness, these techniques, as selected and modified to be used together in the methodology, form a cadre of computational tools specifically tailored for integrated flight control system preliminary design purposes. While theory and associated computational means are an important aspect of the design methodology, the lore, knowledge and experience elements, which guide and govern applications are critical features. This material is presented as summary tables, outlines, recipes, empirical data, lists, etc., which encapsulate a great deal of expert knowledge. Much of this is presented in topical knowledge summaries which are attached as Supplements. The composite of the supplements and the main body elements constitutes a first cut at a a Mark 1 Knowledge Base for manned-aircraft flight control. Author

N89-26014*# Systems Technology, Inc., Hawthorne, CA.
ADVANCED PILOTED AIRCRAFT FLIGHT CONTROL SYSTEM DESIGN METHODOLOGY. VOLUME 2: THE FCX FLIGHT CONTROL DESIGN EXPERT SYSTEM Final Report
Thomas T. Myers and Duane T. McRuer Oct. 1988 190 p
(Contract NAS1-17987)
(NASA-CR-181726-Vol-2; NAS 1.26:181726-Vol-2; STI-TR-1228-1) Avail: NTIS HC A09/MF A01 CSCL 01C

The development of a comprehensive and electric methodology for conceptual and preliminary design of flight control systems is presented and illustrated. The methodology is focused on the design states starting with the layout of system requirements and ending when some viable competing system architectures (feedback control structures) are defined. The approach is centered on the human pilot and the aircraft as both the sources of, and the keys to the solution of, many flight control problems. The methodology relies heavily on computational procedures which are highly interactive with the design engineer. To maximize effectiveness, these techniques, as selected and modified to be used together in the methodology, form a cadre of computational tools specifically tailored for integrated flight control system preliminary design purposes. The FCX expert system as presently developed is only a limited prototype capable of supporting basic lateral-directional FCS design activities related to the design example used. FCX presently supports design of only one FCS architecture (yaw damper plus roll damper) and the rules are largely focused on Class IV (highly maneuverable) aircraft. Despite this limited scope, the major elements which appear necessary for application of knowledge-based software concepts to flight control design were assembled and thus FCX represents a prototype which can be tested, critiqued and evolved in an ongoing process of development. Author

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

N89-26015# National Aerospace Lab., Tokyo (Japan).
THE SCHLIEREN OBSERVATION SYSTEM INSTALLED IN THE NAL TWO-DIMENSIONAL HIGH-REYNOLDS NUMBER TRANSONIC WIND TUNNEL AND ATTEMPTS TO IMPROVE IT
Yasuo Oguni, Mamoru Sato, Hiroshi Kanda, Seizo Sakakibara, and Hitoshi Miwa Mar. 1988 23 p
(NAL-TR-964; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

For years attempts were made to improve the resolution of a colored Schlieren system used in the NAL2DHi-Re transonic wind tunnel. Experience was gained as to the relative advantages between the two colored Schlieren systems: the prism method and the color-filter method. The change of color is continuous for change of fluid density gradient with the former method while discontinuous with the latter. However, the latter method is less susceptible to disturbances due to density fluctuations in the plenum chamber through which the rays travel before being recorded, and is more appropriate when displaying qualitative pictures of the flow field. Firstly an attempt was made to cope with the plenum chamber noises by using a system with a cylindrical channel to isolate the ray paths from the disturbing plenum environment. Secondly to get better resolution for quantifying density gradients, a filter with a fine array of colors was successfully tried; the array consists of 47 stripes, each containing seven colors alternately from red to purple. The density gradients along the model surface were estimated from the Schlieren record, and were favorably compared with those obtained from the surface pressure

distribution data. While it was observed that more improvement of the resolution is needed for accurate determination of the density field, the results so far show the merit of further exploring the procedure for deriving a density gradient field from two Schlieren records by using filters with the stripes of colors perpendicular to each other. Author

N89-26016# National Aerospace Lab., Tokyo (Japan).
A NUMERICAL SIMULATION OF A NEW OPERATION METHOD FOR SHOCK TUNNELS
Masao Shirouzu Aug. 1988 22 p In JAPANESE; ENGLISH summary
(NAL-TR-993; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

A new operation method for shock tunnels which was verified experimentally provides a much longer flow duration than that obtained by conventional methods. The new method employs an orifice plate between the driver and driven sections in order to modify the pressure history at the end of the driven section (i.e., stagnation condition for the nozzle flow) so that the pressure may stabilize much earlier than when an orifice plate is not used. The first and the second diaphragms are replaced by high-speed valves. The second high-speed valve is kept closed until the pressure is stabilized. Although the effectiveness of this method was verified experimentally, a technique for predicting the characteristics of facilities was necessary in order to choose the operation parameters for the middle-scale shock tunnel and to modify the tunnel. Numerical simulations of the flow in the shock tunnel under the new method were made employing the PLM (piecewise linear method). Flow was calculated two-dimensionally in the region near the orifice and one-dimensional flow was assumed in other regions. The simulated pressure history agreed well with the experimental results under various opening area ratios of the orifice. A method was proposed to reduce disturbance in the stagnation pressure caused by the rarefaction wave in the driver section and its effect was verified experimentally. An example of this method, the optimal opening ratio of the orifice for a pre-heated shock tunnel, is provided. The NAL gun tunnel is being changed to this type of tunnel. Some guiding principles are given for the optimal design of a shock tunnel using the new operation method. Author

N89-26017*# Vanderbilt Univ., Nashville, TN. Dept. of Electrical Engineering.
AN AUTOMATION SIMULATION TESTBED Report, Oct. 1987 - Sep. 1988
George E. Cook, Janos Sztipanovits, Csaba Biegl, Gabor Karsai, James F. Springfield, and Atheel Mutammara Sep. 1988 114 p Original contains color illustrations
(Grant NAG8-690)
(NASA-CR-185444; NAS 1.26:185444) Avail: NTIS HC A06/MF A01 CSCL 14B

The work being done in porting ROBOSIM (a graphical simulation system developed jointly by NASA-MSFC and Vanderbilt University) to the HP350SRX graphics workstation is described. New additional ROBOSIM features, like collision detection and new kinematics simulation methods are also discussed. Based on the experiences of the work on ROBOSIM, a new graphics structural modeling environment is suggested which is intended to be a part of a new knowledge-based multiple aspect modeling testbed. The knowledge-based modeling methodologies and tools already available are described. Three case studies in the area of Space Station automation are also reported. First a geometrical structural model of the station is presented. This model was developed using the ROBOSIM package. Next the possible application areas of an integrated modeling environment in the testing of different Space Station operations are discussed. One of these possible application areas is the modeling of the Environmental Control and Life Support System (ECLSS), which is one of the most complex subsystems of the station. Using the multiple aspect modeling methodology, a fault propagation model of this system is being built and is described. K.C.D.

N89-26018# Army Armament Research and Development Command, Dover, NJ. Development and Engineering Center.
AIRCRAFT JET ENGINE EXHAUST BLAST EFFECTS ON PAR-56 RUNWAY THRESHOLD LAMP FIXTURES Final Report
Jacob K. Struck and Anthony J. Barile (Federal Aviation Administration, Atlantic City, NJ.) Jun. 1989 79 p
(Contract DTFA03-84-A-40020)
(DOT/FAA/CT-89/4) Avail: NTIS HC A05/MF A01

The effects of jet engine exhaust blast on PAR-56 lamps located at the runway threshold were measured. Sensors were placed on and near the lamp assemblies which measured blast velocity and temperature, bulb face temperature, lamp fixture acceleration and sound pressure level. These sensors were coupled to a computer controlled instrumentation system housed in a van located near the threshold of runway 13 at La Guardia Airport. Data were acquired during the engine runup and takeoff roll of some 162 aircraft during the measurement phase. The data were recorded on digital magnetic tape and video tape to form a permanent record of the raw data. The data were later plotted and analyzed, both manually and using a computer in order to extract the worst case environmental parameters encountered during the measurement phase. A prediction algorithm was developed to allow prediction of key environmental effects on the PAR-56 lamps caused by new aircraft or aircraft not measured. The algorithm was developed by correlating the acquired data against the manufacturers' published jet exhaust blast velocity and temperature contours. A protective shroud was devised and installed on one of the instrumented lamp assemblies during the last portion of data collection. The data suggest a beneficial reduction of the hostile jet blast effects measured on the shrouded lamp versus the unshrouded lamp. Author

N89-26019# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
DESIGN CRITERIA FOR AGGREGATE-SURFACED ROADS AND AIRFIELDS Final Report, 1986 - 1988
Yu T. Chou Apr. 1989 113 p
(DA Proj. 4A1-62719-AT-40)
(AD-A207059; WES/TR/GL-89-5) Avail: NTIS HC A06/MF A01 CSCL 01/5

Failure criteria for aggregate-surfaced pavements subject to vehicular and aircraft loadings are developed. The criteria determine the required thickness making use of the layered elastic design procedure. A literature study was conducted to determine existing design procedures that might be applicable. Types of distresses in aggregate pavements were identified. Those basic parameters that influence performance were defined. Efforts were made to compare the existing design procedures using hypothetical design conditions, and the differences between the procedures were discussed. The technique of reliability analysis was applied on the design procedures. It was found that the reliabilities of some procedures were very low. Field tests on subgrade soils covered with high strength aggregates are recommended. The tests are necessary for the verification of developed failure criteria. GRA

N89-26020# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
EVALUATION OF NONDESTRUCTIVE TEST EQUIPMENT FOR AIRFIELD PAVEMENTS. PHASE 1: CALIBRATION TEST RESULTS AND FIELD DATA COLLECTION Final Report, Feb. 1986 - Jun. 1988
Ross A. Bentsen, Albert J. Bush, III, and J. A. Harrison Jan. 1989 331 p Sponsored in part by Department of the Air Force, Tyndall AFB, FL and Department of the Navy, Alexandria, VA
(Contract DTFA01-87-Z-02015)
(AD-A207159; WES/TR/GL-89-3; ESL-TR-88-52; DOT/FAA/DS-88/03) Avail: NTIS HC A15/MF A01 CSCL 14/2

This study evaluates seven nondestructive testing devices for use on airfield pavements. Four falling weight deflectometers and three vibrators were evaluated for accuracy, repeatability, and reliability. Deflection data were collected on 12 pavements

consisting of thick and thin asphalt concrete, portland cement concrete, and composite (asphalt concrete over portland cement concrete) pavements over fine and coarse grain subgrades. This report describes the test program, presents results of accuracy and repeatability tests, and presents the deflection data collected on the 12 pavements. GRA

N89-26021# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Hauptabteilung Windkanaele.
THE 3m X 3m LOW SPEED WIND TUNNEL (NWG) AT DFVLR IN GOETTINGEN (GERMANY, F.R.) Status Report, 1988
Werner Baumert et al Sep. 1988 71 p In GERMAN; ENGLISH summary Original contains color illustrations
(DFVLR-Mitt-89-05; ISSN-0176-7739; ETN-89-94983) Avail: NTIS HC A04/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany DM 36

Information for users of the Low-Speed Wind Tunnel (NWG) is given. The NWG is a continuously working wind tunnel. The open jet test section has a cross section size of 3 m x 3 m with a length of 6 m. Maximum wind speed is 65 m/s; maximum Reynolds number is Re = 1.3 million based on a reference length of 0.3 m. ESA

12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

N89-26022*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
AUTONOMOUS FREQUENCY DOMAIN IDENTIFICATION: THEORY AND EXPERIMENT
Yeung Yam, D. S. Bayard, F. Y. Hadaegh, E. Mettler, M. H. Milman, and R. E. Scheid 15 Apr. 1989 218 p
(Contract NAS7-918)
(NASA-CR-184811; JPL-Publ-89-8; NAS 1.26:184811) Avail: NTIS HC A10/MF A01 CSCL 22A

The analysis, design, and on-orbit tuning of robust controllers require more information about the plant than simply a nominal estimate of the plant transfer function. Information is also required concerning the uncertainty in the nominal estimate, or more generally, the identification of a model set within which the true plant is known to lie. The identification methodology that was developed and experimentally demonstrated makes use of a simple but useful characterization of the model uncertainty based on the output error. This is a characterization of the additive uncertainty in the plant model, which has found considerable use in many robust control analysis and synthesis techniques. The identification process is initiated by a stochastic input u which is applied to the plant p giving rise to the output. Spectral estimation (h = P sub uy/P sub uu) is used as an estimate of p and the model order is estimated using the produce moment matrix (PMM) method. A parametric model unit direction vector p is then determined by curve fitting the spectral estimate to a rational transfer function. The additive uncertainty delta sub m = p - unit direction vector p is then estimated by the cross spectral estimate delta = P sub ue/P sub uu where e = y - unit direction vectory y is the output error, and unit direction vector y = unit direction vector pu is the computed output of the parametric model subjected to the actual input u. The experimental results demonstrate the curve fitting algorithm produces the reduced-order plant model which minimizes the additive uncertainty. The nominal transfer function estimate unit direction vector p and the estimate delta of the additive uncertainty delta sub m are subsequently available to be used for optimization of robust controller performance and stability. Author

13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

N89-26023# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
INVESTIGATION OF THE EFFECTS OF TIME TRANSFORMATION, STABILIZATION, AND REGULARIZATION ON NUMERICAL ORBIT PROPATATION M.S. Thesis [INVESTIGACAO SOBRE OS EFEITOS DA TRANSFORMACAO DE TEMP, ESTABILIZACAO E REGULARIZACAO EM PROPAGACAO NUMERICA DE ORBITA]
Sebastiao Cicero PinheiroGomes Dec. 1987 184 p In PORTUGUESE; ENGLISH summary
(INPE-4555-TDL/330) Avail: NTIS HC A09/MF A01

Several formulations of the differential equations of the orbital motion for use in numerical orbit propagation were investigated. The theories which gave rise to various formulations are presented along with simulations of numerical propagation. The simulations were carried out using three different numerical integrators with fixed step size, namely: fourth order Runge-Kutta, eighth order Runge-Kutta and eighth order multistep predictor-corrector. The first things studied were the Sundman time transformation, which yields and analytical step size control; the stabilization of differential equations, which promotes enhancements on the numerical behavior of the integration; and the regularization, which eliminates the singularities in the differential equations of keplerian motion. A new time transformation was proposed, in order to obtain a more efficient analytical step size control in an attempt to redistribute more equitably the arc lengths along one orbital revolution. It's noted that in all different formulations the physical time is obtained numerically as a generalized coordinate of the system. Because of this, a full chapter to study the global error on this coordinate as well as its influence when obtaining the propagated orbit. Also, a mechanism called time element to obtain a more accurate physical time was studied. Finally, some general conclusion as well as some comments about the efficiency of the formulations in terms of accuracy and processing time were presented. Author

N89-26024*# Old Dominion Univ., Norfolk, VA. Dept. of Electrical and Computer Engineering.
FUEL-OPTIMAL TRAJECTORIES OF AEROASSISTED ORBITAL TRANSFER WITH PLANE CHANGE Progress Report, period ending 30 Jun. 1989
Desineni Subbaramaia Naidu and Joseph L. Hibey 30 Jun. 1989 64 p
(Grant NAG1-736)
(NASA-CR-185334; NAS 1.26:185334) Avail: NTIS HC A04/MF A01 CSCL 22A

The problem of minimization of fuel consumption during the atmospheric portion of an aeroassisted, orbital transfer with plane change is addressed. The complete mission has required three characteristic velocities, a deorbit impulse at high earth orbit (HEO), a boost impulse at the atmospheric exit, and a reorbit impulse at low earth orbit (LEO). A performance index has been formulated as the sum of these three impulses. Application of optimal control principles has led to a nonlinear, two-point, boundary value problem which was solved by using a multiple shooting algorithm. The strategy for the atmospheric portion of the minimum-fuel transfer is to start initially with the maximum positive lift in order to recover from the downward plunge, and then to fly with a gradually decreasing lift such that the vehicle skips out of the atmosphere with a flight path angle near zero degrees. Author

14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

N89-26025*# Arizona Univ., Tucson.
DESIGN OF A FLEXURE MOUNT FOR OPTICS IN DYNAMIC AND CRYOGENIC ENVIRONMENTS
Lloyd Wayne Pollard Feb. 1989 135 p
(Contract NCC2-426)
(NASA-CR-177495; NAS 1.26:177495) Avail: NTIS HC A07/MF A01 CSCL 14B

The design of a flexure mount for a mirror operating in a cryogenic environment is presented. This structure represents a design effort recently submitted to NASA Ames for the support of the primary mirror of the Space Infrared Telescope Facility (SIRTF). The support structure must passively accommodate the differential thermal contraction between the glass mirror and the aluminium structure of the telescope during cryogenic cooldown. Further, it must support the one meter diameter, 116 kilogram (258 pound) primary mirror during a severe launch to orbit without exceeding the micro-yield of the material anywhere in the flexure mount. Procedures used to establish the maximum allowable radial stiffness of the flexural mount, based on the finite element program NASTRAN and the optical program FRINGE, are discussed. Early design concepts were evaluated using a parametric design program, and the development of that program is presented. Dynamic loading analyses performed with NASTRAN are discussed. Methods of combining modal responses resulting from a displacement response spectrum analysis are discussed, and a combination scheme called MRSS, modified root of sum of squares, is presented. Model combination schemes using MRSS, SRSS, and ABS are compared to the results of the modal frequency response analysis performed with NASTRAN. Author

N89-26026# Range Commanders Council, White Sands Missile Range, NM. Inter-range Instrumentation Ion Group.
TIME CODE FORMATS Final Report
Mar. 1989 46 p
(AD-A206580; IRIG-STANDARD-200-89) Avail: NTIS HC A03/MF A01 CSCL 14/2

Modern day electronic systems such as communication systems, data handling systems, missile and spacecraft tracking, and telemetry systems require time-of-day information for data correlation with time. Parallel and serial formatted time codes are used to efficiently interface the timing system (time-of-day source) to the user system. Parallel time codes are defined in IRIG Standard 205-87. Standardization of time codes is necessary to ensure system compatibility among the various ranges, ground tracking networks, spacecraft and missile projects, data reduction and processing facilities, and international cooperative projects. This standard defines the characteristics of six serial time codes presently used by U.S. Government agencies and private industry. Four new combinations have been added to the list of standard formats: A002, A132, B002, and B122. Moreover, this standard reflects the state of the art and is not intended to constrain proposals for new serial time codes with greater resolution. GRA

N89-26344*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
METHODS AND DECISION MAKING ON A MARS ROVER FOR IDENTIFICATION OF FOSSILS Abstract Only
Susan Eberlein and Gigi Yates *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 17-18
(For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 14B

N89-26460*# California Inst. of Tech., Pasadena.
SYSTEM ENGINEERING TECHNIQUES FOR ESTABLISHING BALANCED DESIGN AND PERFORMANCE GUIDELINES FOR THE ADVANCED TELEROBOTIC TESTBED
W. F. Zimmerman and J. R. Matijevic *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 67-73 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 14B

15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

N89-26027*# Sverdrup Technology, Inc., Cleveland, OH.
THE DEVELOPMENT OF POWER SPECIFIC REDLINES FOR SSME SAFETY MONITORING Final Report
William A. Maul and Claudia M. Bosch Jun. 1989 36 p Presented at the 25th Joint Propulsion Technology Division, Monterey, CA, 10-12 Jul. 1989; cosponsored by the AIAA, ASME, SAE, and ASEE
(Contract NAS3-25266)
(NASA-CR-185121; E-4949; NAS 1.26:185121; AIAA-89-2413)
Avail: NTIS HC A03/MF A01 CSCL 14B

Over the past several years, there has been an increased awareness in the necessity for rocket engine health monitoring because of the cost and complexity of present and future systems. A current rocket engine system, the Space Shuttle Main Engine (SSME), combines a limited redline system with closed-loop control of the engine's thrust level and mixture ratio. Despite these features, 27 tests of the SSME have resulted in major incidents. A SSME transient model was used to examine the effect of variations in high pressure turbopump performance on various engine parameters. Based on analysis of the responses, several new parameters are proposed for further investigation as power-level specific redlines. Author

16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

N89-26028*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
KSC ICE/FROST/DEBRIS ASSESSMENT FOR SPACE SHUTTLE MISSION STS-29R
Charles G. Stevenson, Gregory N. Katnik, and Scott A. Higginbotham Apr. 1989 196 p
(NASA-TM-102148; NAS 1.15:102148) Avail: NTIS HC A09/MF A01 CSCL 22B

An ice/frost/debris assessment was conducted for Space Shuttle Mission STS-29R. Debris inspections of the flight elements and launch pad are performed before and after launch. Ice/frost conditions on the external tank are assessed by the use of computer programs, nomographs, and infrared scanner data during cryogenic loading of the vehicle followed by an on-pad visual inspection. High speed photography is analyzed after launch to identify ice/debris sources and evaluate potential vehicle damage. The ice/frost/debris conditions of Mission STS-29R and their effect on the Space Shuttle Program are documented. Author

N89-26462*# Martin Marietta Aerospace, Denver, CO.
SHUTTLE BAY TELEROBOTICS DEMONSTRATION

W. Chun and P. Cogeos *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 83-90 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

N89-26594*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Artificial Intelligence Group.
SHARP: A MULTI-MISSION AI SYSTEM FOR SPACECRAFT TELEMETRY MONITORING AND DIAGNOSIS
Denise L. Lawson and Mark L. James *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 185-200 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09F

N89-26595*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
REDEX: THE RANGING EQUIPMENT DIAGNOSTIC EXPERT SYSTEM
Edward C. Luczak, K. Gopalakrishnan (Computer Sciences Corp., Beltsville, MD.), and David J. Zillig *In its* The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 201-211 (For primary document see N89-26578 20-63)
(Contract NAS5-31500)
Avail: NTIS HC A17/MF A01 CSCL 09F

18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

N89-26029 Ohio State Univ., Columbus.
LOCAL CONTROL STRATEGIES FOR A CLASS OF INTERCONNECTED AND KNOWLEDGE-RICH HIERARCHICAL SYSTEMS Ph.D. Thesis
Levent Acar 1988 166 p
Avail: Univ. Microfilms Order No. DA8824448

Suboptimal and optimal local control strategies for large systems with both dynamic equation descriptions and functional representations are considered. First, local suboptimal control strategies are developed for interconnected systems described by dynamic equations. The local control is required to optimize a finite horizon quadratic cost function. On the other hand, the optimal control can be achieved by data transfers between subsystems which form a distributed network of processors. Two different methods are also developed for distributed computations with different granularity. These control strategies are then extended beyond the horizon limit by repeated updates. The relation of interaction strength and the horizon length on stability of interconnected systems is addressed as well as the performance of the control. Then, a unified hierarchical structure is proposed for systems with functional descriptions. Hierarchical structures have been part of the heuristic design and control of large scale systems for a number of years. Hierarchies offer compressed knowledge and data storage with different levels of detail and simplify control by considering small portions of a bigger problem. The proposed hierarchy is composed of knowledge rich controllers which are formed by embedding the knowledge to control with structural information. The description of the hierarchical organization is given in an axiomatic approach and a local uniform control flow through the structure is presented. Some applications are also included to show the applicability of the proposed hierarchy for systems with various ranges of functionality. Dissert. Abstr.

N89-26030# Los Alamos National Lab., NM.
OPERATIONAL RESULTS OF THE BEAR (BEAM EXPERIMENTS ABOARD A ROCKET) FLIGHT RF SYSTEM
Michael T. Lynch and John C. Devenport 1989 14 p Presented at the 13th Particle Accelerator Conference, Chicago, IL, 20 Mar. 1989
(Contract W-7405-eng-36)
(DE89-009291; LA-UR-89-888; CONF-890335-50) Avail: NTIS HC A03/MF A01

The Beam Experiments Aboard a Rocket (BEAR) flight rf control system has been completely designed and has been operated as a part of the flight accelerator system in the actual flight configuration. The accelerator has been vertically integrated onto the flight support structure (space frame) and has been operated in this configuration in preparation for the actual flight which is scheduled for late Spring, 1989. The rf control system consists of redundant voltage controlled oscillators, redundant amplitude controllers which maintain the proper fields in the RFQ, a frequency controller to maintain operation at the resonant frequency of the RFQ, and the necessary system monitors and interfaces required for the amplifiers, onboard system controller, and telemetry. The rf controller had to meet the electrical and environmental requirements while staying within its weight limit. This paper describes the final design of the rf controller and results from operation of the controller in its final flight configuration.
DOE

N89-26031*# Sverdrup Technology, Inc., Cleveland, OH.
TWO-TIERED DESIGN ANALYSIS OF A RADIATOR FOR A SOLAR DYNAMIC POWERED STIRLING ENGINE Final Report
Donald C. Hainley Jun. 1989 9 p Prepared for presentation at the 24th Intersociety Energy Conversion Engineering Conference, Washington, DC, 6-11 Aug. 1989; sponsored in part by IEEE, AIAA, ANS, ASME, SAE, ACS, and AIChE
(Contract NAS3-25266)
(NASA-CR-182301; E-4851; NAS 1.26:182301) Avail: NTIS HC A02/MF A01 CSCL 22B

Two separate design approaches for a pumped loop radiator used to transfer heat from the cold end of a solar dynamic powered Stirling engine are described. The first approach uses a standard method to determine radiator requirements to meet specified end of mission conditions. Trade-off studies conducted for the analysis are included. Justification of this concept within the specified parameters of the analysis is provided. The second design approach determines the life performance of the radiator/Stirling system. In this approach, the system performance was altered by reducing the radiator heat transfer area. Performance effects and equilibrium points were determined as radiator segments were removed. This simulates the effect of loss of radiator sections due to micro-meteoroid and space debris penetration. The two designs were compared on the basis of overall system requirements and goals.
Author

N89-26032*# North Carolina Univ., Charlotte. Dept. of Electrical Engineering.
CONTROL OF SPACECRAFT CONTROL LABORATORY EXPERIMENT (SCOLE) SLEW MANEUVERS
Y. P. Kakad [1987] 28 p
(Grant NAG1-535)
(NASA-CR-185361; NAS 1.26:185361) Avail: NTIS HC A03/MF A01 CSCL 22B

This is the second report of a set of two reports on the dynamics and control of slewing maneuvers of NASA Spacecraft Control

Laboratory Experiment (SCOLE). The control problem of slewing maneuvers of SCOLE is developed in terms of an arbitrary maneuver about any given axis. The control system is developed for the combined problem of rigid-body slew maneuver and vibration suppression of flexible appendage. The control problem is formulated by incorporating the nonlinear equations derived in the previous report and is expressed in terms of a two-point boundary value problem utilizing a quadratic type of performance index. The two-point boundary value problem is solved as a hierarchical control problem with the overall system being split in terms of two subsystems, namely the slewing of the entire assembly and the vibration suppression of the flexible antenna. The coupling variables between the two dynamical subsystems are identified and these two subsystems for control purposes are treated independently in parallel at the first level. Then the state-space trajectory of the combined problem is optimized at the second level. Author

N89-26033# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Dept. of Control and Guidance.
THE ROLE OF PRECISION MECHANICS IN A SATELLITE PROGRAM: INPE'S EXPERIENCE
Agenor de Toledo Fleury and Petronio Noronha deSouza Aug. 1988 19 p
(INPE-4683-PRE/1378) Avail: NTIS HC A03/MF A01

Some aspects concerning the design and the construction of precision mechanisms are described for use in the satellites of the Brazilian Complete Space Mission (MECB) and in the Institute of Space Research's (INPE's) future satellite programs. This is done through an explanation of MECB missions, in order to introduce the systems where precision mechanics is a necessity followed by a discussion about the most representative precision equipment in development at INPE. A prospective view of the need of precision mechanics to attend to all areas involved in satellite programs is presented in the sequence. Finally, some actions to implement a precision engineering program as a support to the Brazilian Space Missions are proposed and discussed. Author

N89-26034*# Oregon Univ., Eugene. Dept. of Computer and Information Science.
QUALITATIVE MECHANISM MODELS AND THE RATIONALIZATION OF PROCEDURES Final Report
Arthur M. Farley 10 Jul. 1989 41 p
(Grant NAG2-383)
(NASA-CR-185452; NAS 1.26:185452) Avail: NTIS HC A03/MF A01 CSCL 22B

A qualitative, cluster-based approach to the representation of hydraulic systems is described and its potential for generating and explaining procedures is demonstrated. Many ideas are formalized and implemented as part of an interactive, computer-based system. The system allows for designing, displaying, and reasoning about hydraulic systems. The interactive system has an interface consisting of three windows: a design/control window, a cluster window, and a diagnosis/plan window. A qualitative mechanism model for the ORS (Orbital Refueling System) is presented to coordinate with ongoing research on this system being conducted at NASA Ames Research Center. K.C.D.

N89-26035*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EFFECT OF MICROMETEOROID AND SPACE DEBRIS IMPACTS ON THE SPACE STATION FREEDOM SOLAR ARRAY SURFACES
Henry K. Nahra 1989 12 p Presented at the 1989 Spring Meeting of the Materials Research Society, San Diego, CA, 24-29 Apr. 1989
(NASA-TM-102287; E-4955; NAS 1.15:102287) Avail: NTIS HC A03/MF A01 CSCL 22B

Both solar and antisolar surfaces of the Space Station Freedom solar arrays are vulnerable to micrometeoroid and space debris impacts. Impacts on the solar surface result in damage to the active area of the solar cell and a corresponding reduction in generated power. Impacts on the antisolar surface could result in damage to the circuit which interconnects the cells which in turn may produce open circuit strings or panels. An evaluation is presented of the power degradation resulting from the impacts of micrometeoroid and space debris on the solar surface of the array blanket. Moreover, given a particle diameter that could damage the circuit interconnecting the cells, the probability of an open circuit panel is computed, along with the probability that the solar array blanket will meet the power requirement over the design lifetime. Author

N89-26036*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COLD-SAT: A TECHNOLOGY SATELLITE FOR CRYOGENIC EXPERIMENTATION
H. Arif and E. W. Kroeger 1989 13 p Presented at the 1989 Cryogenic Engineering Conference and International Cryogenic Materials Conference, Los Angeles, CA, 24-28 Jul. 1989; sponsored by UCLA
(NASA-TM-102286; E-4953; NAS 1.15:102286) Avail: NTIS HC A03/MF A01 CSCL 22B

NASA-Lewis (LeRC) is involved in the development and validation of analytical models which describe the fluid dynamic and thermodynamic processes associated with the storage, acquisition and transfer of subcritical cryogenic fluids in low gravity. Four concurrent studies, including one in-house at LeRC, are underway to determine the feasibility of performing model validation experiments aboard a free-flying spacecraft (S/C) called Cryogenic On-Orbit Liquid Depot-Storage, Acquisition and Transfer (COLD-SAT), using liquid hydrogen as the cryogen. The technology requirements for the experiments are described along with the initial LeRC concepts for the S/C and an experiment subsystem comprising of cryogenic tankage (a supply dewar and three receiver tanks), gas pressurization bottles (both helium and autogenous hydrogen), their associated plumbing, and instrumentation for data collection. Experiments were categorized into enabling/high priority Class 1 technologies and component/system Class 2 demonstrations. As initially envisioned by LeRC, COLD-SAT would have had a 1997 launch aboard a Delta-2 for a 6 month active lifetime in a 925 km orbit with a pseudo-inertial attitude. Author

N89-26037* National Aeronautics and Space Administration, Washington, DC.
TECHNOLOGY FOR LARGE SPACE SYSTEMS: A BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 20)
Jun. 1989 183 p
(NASA-SP-7046(20); NAS 1.21:7046(20)) Avail: NTIS HC A09 CSCL 22B

This bibliography lists 694 reports, articles, and other documents introduced into the NASA Scientific and Technical Information System between July, 1988 and December, 1988. Its purpose is to provide helpful information to the researcher or manager engaged in the development of technologies related to large space systems. Subject areas include mission and program definition, design techniques, structural and thermal analysis, structural dynamics and control systems, electronics, advanced materials, assembly concepts, and propulsion. Author

N89-26038 Department of the Air Force, Washington, DC.
EXPANDABLE PULSE POWER SPACECRAFT RADIATOR Patent
Edward T. Mahefkey, inventor (to AF) 21 Mar. 1989 7 p Filed 21 Oct. 1987
(AD-D014102; US-Patent-4,813,476; US-Patent-Appl-SN-110809; US-Patent-Class-165-32) Avail: US Patent and Trademark Office CSCL 20/13

An expandable heat rejection system for radiating heat generated by a source of heat on a spacecraft or like vehicle is described. It is comprised of a fluid heat exchange medium in operative heat exchange contact with the source for absorbing heat by evaporation of the liquid phase of the medium, a thin flexible wall structure having an inlet and an outlet and defining a volume expandable and collapsible between preselected limits and

defining an inner condensation surface and an outer heat radiating surface, a multiplicity of capillary grooves on the condensation surface for promoting condensation of vaporous medium and for facilitating flow of condensate along the condensation surface toward the outlet, and a pump for circulating the medium through the system. GRA

N89-26458*# Grumman Aerospace Corp., Bethpage, NY. Space Systems Div.
TELEROBOTIC ASSEMBLY OF SPACE STATION TRUSS STRUCTURES
G. Fischer *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 45-53 Previously announced as N87-18984 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

N89-26459*# Lockheed Missiles and Space Co., Sunnyvale, CA.
ROBOTIC MOBILE SERVICING PLATFORM FOR SPACE STATION
S. H. Lowenthal and L. VanErden *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 55-65 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

N89-26461*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
DEDICATED ROBOTIC SERVICING FOR THE SPACE STATION
R. F. Thompson, G. Arnold, and D. Gutow *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 75-82 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

N89-26463*# California Univ., Berkeley.
TELEROBOTICS: RESEARCH NEEDS FOR EVOLVING SPACE STATIONS
L. Stark *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 91-94 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

N89-26543*# Edinburgh Univ. (Scotland).
CONTINGENT PLAN STRUCTURES FOR SPACECRAFT
M. Drummond, K. Currie, and A. Tate *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 17-25 (For primary document see N89-26541 20-63)
(Grants GR/D/58987; GR/E/05421)
Avail: NTIS HC A18/MF A01 CSCL 22B

N89-26590*# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France).
A METHOD FOR INTERACTIVE SATELLITE FAILURE DIAGNOSIS: TOWARDS A CONNECTIONIST SOLUTION
P. Bourret and James A. Reggia (Maryland Univ., College Park.) *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 143-152 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 22B

N89-26592*# Westinghouse Electric Corp., Baltimore, MD.
TRACKING AND DATA RELAY SATELLITE FAULT ISOLATION AND CORRECTION USING PACES: POWER AND ATTITUDE CONTROL EXPERT SYSTEM
Carol-Lee Erikson and Peggy Hooker (McDonnell-Douglas Space Systems Co., Cocoa Beach, FL.) *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 161-168 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 22B

19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

N89-26039# Institute for Defense Analyses, Alexandria, VA.
EXPOSURE TO ICBM (INTERCONTINENTAL BALLISTIC MISSILES) AND SLBM (SOVIET LAUNCHED BALLISTIC MISSILES) TRAJECTORIES TO SUNLIGHT Final Report, Aug. - Dec. 1988
Thomas S. Paterson Jan. 1989 22 p
(Contract MDA903-84-C-0031)
(AD-A206857; AD-E501080; IDA-M-520; IDA/HQ-88-33788)
Avail: NTIS HC A03/MF A01 CSCL 16/2

Due to the cost and complexity of infrared and radar sensors, visible sensors could be a useful alternative for strategic defense surveillance systems, provided the threat is exposed to sunlight for a significant portion of its trajectory. This paper examines the exposure of ballistic missile trajectories to sunlight as a function of solar latitude (time of year) and launch time. Nine representative trajectories were chosen to illustrate the effects of range, apogee, and maximum latitude on sunlight exposure. It was found that certain Soviet-to-CONUS trajectories would be completely in the Earth's shadow only when launched during a brief time window on or near the winter solstice. Certain SLBM trajectories had full-shadow launch windows from late fall to early spring. However, trajectories representing those of SS-18's flew very close to the pole, exposing most of their paths to sunlight regardless of launch time or solar latitude. Weighting the trajectories to represent aggregates of a Soviet spike attack, at least 69 percent of the threat was exposed to sunlight for at least 500 seconds on the winter solstice, and at least 95 percent was exposed on the spring/fall equinoxes. These percentages exceed the JCS requirements of a Phase One Strategic Defense System, particularly because of the susceptibility of SS-18 trajectories to sunlight exposure. GRA

N89-26338*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STABLE ISOTOPE LASER SPECTROSCOPY Abstract Only
J. F. Becker, Ramil Yaldaei (San Jose State Univ., CA.), and Christopher P. McKay *In its* Exobiology and Future Mars Missions Mar. 1989 p 9 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 14B

20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

N89-26040# National Aerospace Lab., Tokyo (Japan).
EXPERIMENTAL STUDY ON HIGH PRESSURE LIQUID OXYGEN PUMP
Mitsuo Watanabe, Satoshi Hasegawa, Kenjiro Kamijo, and Hiroshi Aoki Feb. 1988 14 p In JAPANESE; ENGLISH summary
(NAL-TR-959; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

Recently, a two-stage combustion cycle was applied to liquid rocket engines in order to obtain high performance. However, the engine cycle inevitably requires extremely high pressure propellant feed pumps which require quite high technology. In order to investigate the characteristics of high pressure cryogenic pumps, a small high pressure and high speed liquid oxygen (LOX) pump

was designed, fabricated and tested from 1980 to 1983 in the National Aerospace Laboratory (NAL) in cooperation with the National Space Development Agency of Japan (NASDA). It is a single-stage centrifugal pump with a three bladed helical inducer. The designed rotational speed is 47,500 rpm. Points of technology studied in the recent experiments included establishing fluid dynamic design details and mechanical design details such as a thrust balancing system, and bearing and seal systems. Author

N89-26041*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ADVANCES IN THIN-FILM SOLAR CELLS FOR LIGHTWEIGHT SPACE PHOTOVOLTAIC POWER

Geoffrey A. Landis, Sheila G. Bailey, and Dennis J. Flood 1989 29 p Presented at the International Conference on Space Power, Cleveland, OH, 5-7 Jun. 1989; sponsored by the International Astronautical Federation

(NASA-TM-102017; E-4734; NAS 1.15:102017) Avail: NTIS HC A03/MF A01 CSCL 10A

The present stature and current research directions of photovoltaic arrays as primary power systems for space are reviewed. There have recently been great advances in the technology of thin-film solar cells for terrestrial applications. In a thin-film solar cell the thickness of the active element is only a few microns; transfer of this technology to space arrays could result in ultralow-weight solar arrays with potentially large gains in specific power. Recent advances in thin-film solar cells are reviewed, including polycrystalline copper-indium selenide (CuInSe2) and related I-III-VI2 compounds, polycrystalline cadmium telluride and related II-VI compounds, and amorphous silicon:hydrogen and alloys. The best experimental efficiency on thin-film solar cells to date is 12 percent AMO for CuIn Se2. This efficiency is likely to be increased in the next few years. The radiation tolerance of thin-film materials is far greater than that of single-crystal materials. CuIn Se2 shows no degradation when exposed to 1 MeV electrons. Experimental evidence also suggests that most of all of the radiation damage on thin-films can be removed by a low temperature anneal. The possibility of thin-film multibandgap cascade solar cells is discussed, including the tradeoffs between monolithic and mechanically stacked cells. The best current efficiency for a cascade is 12.5 percent AMO for an amorphous silicon on CuInSe2 multibandgap combination. Higher efficiencies are expected in the future. For several missions, including solar-electric propulsion, a manned Mars mission, and lunar exploration and manufacturing, thin-film photovolatic arrays may be a mission-enabling technology. Author

N89-26042*# Texas A&M Univ., College Station. Power System Automation Lab.

ADVANCED POWER SYSTEM PROTECTION AND INCIPIENT FAULT DETECTION AND PROTECTION OF SPACEBORNE POWER SYSTEMS Final Report

B. Don Russell May 1989 159 p

(Grant NAG9-143)

(NASA-CR-185330; JSC10-86-8483; NAS 1.26:185330) Avail: NTIS HC A08/MF A01 CSCL 10B

This research concentrated on the application of advanced signal processing, expert system, and digital technologies for the detection and control of low grade, incipient faults on spaceborne power systems. The researchers have considerable experience in the application of advanced digital technologies and the protection of terrestrial power systems. This experience was used in the current contracts to develop new approaches for protecting the electrical distribution system in spaceborne applications. The project was divided into three distinct areas: (1) investigate the applicability of fault detection algorithms developed for terrestrial power systems to the detection of faults in spaceborne systems; (2) investigate the digital hardware and architectures required to monitor and control spaceborne power systems with full capability to implement new detection and diagnostic algorithms; and (3) develop a real-time expert operating system for implementing diagnostic and protection algorithms. Significant progress has been made in each of the above areas. Several terrestrial fault detection algorithms were modified to better adapt to spaceborne power system environments. Several digital architectures were developed and evaluated in light of the fault detection algorithms. Author

N89-26043*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

SOLAR CELL RADIATION HANDBOOK. ADDENDUM 1: 1982-1988

Bruce E. Anspaugh 15 Feb. 1989 47 p

(Contract NAS7-918)

(NASA-CR-185465; JPL-Publ-82-69-Add-1; NAS 1.26:185465)

Avail: NTIS HC A03/MF A01 CSCL 10B

The Solar Cell Radiation Handbook (JPL Publication 82-69) is updated. In order to maintain currency of solar cell radiation data, recent solar cell designs have been acquired, irradiated with 1 MeV electrons, and measured. The results of these radiation experiments are reported. Author

N89-26044*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COLD-SAT: AN ORBITAL CRYOGENIC HYDROGEN TECHNOLOGY EXPERIMENT

J. R. Schuster, Joseph P. Wachter (Ford Aerospace and Communications Corp., Palo Alto, CA.), and Albert G. Powers 1989 14 p Presented at the 40th Congress of the International Astronautical Federation, Malaga, Spain, 8-14 Oct. 1989

(NASA-TM-102303; E-4984; NAS 1.15:102303; IAF-89-057)

Avail: NTIS HC A03/MF A01 CSCL 22A

The COLD-SAT spacecraft will perform subcritical liquid hydrogen storage and transfer experiments under low-gravity conditions to provide engineering data for future space transportation missions. Consisting of an experiment module mated to a spacecraft bus, COLD-SAT will be placed in an initial 460 km circular orbit by an Atlas I commercial launch vehicle. After deployment, the three-axis-controlled spacecraft bus will provide electric power, experiment control and data management, communications, and attitude control along with propulsive acceleration levels ranging from 10(-6) to 10(-4)g. These accelerations are an important aspect of some of the experiments, as it is desired to know the effects that low gravity levels might have on the heat and mass transfer processes involved. The experiment module will contain the three liquid hydrogen tanks, valves, pressurization equipment, and instrumentation. At launch all the hydrogen will be in the largest tank, which has helium-purged MLI and is loaded and topped off by the hydrogen tanking system used for the Centaur upper stage of the Atlas. The two smaller tanks will be utilized in orbit for performing some of the experiments. The experiments are grouped into two classes on the basis of their priority, and include six regarded as enabling technology and nine regarded as enhancing technology. Author

N89-26045*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SPACE STATION FREEDOM POWER MANAGEMENT AND DISTRIBUTION SYSTEM DESIGN

Fred Teren 1989 10 p Prepared for presentation at the 40th Congress of the International Astronautical Federation, Malaga, Spain, 8-14 Oct. 1989

(NASA-TM-102283; E-4950; NAS 1.15:102283) Avail: NTIS HC A02/MF A01 CSCL 21H

The design is described of the Space Station Freedom Power Management and Distribution (PMAD) System. In addition, the significant trade studies which were conducted are described, which led to the current PMAD system configuration. Author

23 CHEMISTRY AND MATERIALS (GENERAL)

N89-26046*# Research Triangle Inst., Research Triangle Park, NC.
THERMAL PROTECTION SYSTEM OF THE SPACE SHUTTLE Final Report
John Cleland and Francesco Iannetti (Design Ideas, Raleigh, NC.) Jun. 1989 291 p
(Contract NASw-3841)
(NASA-CR-4227; NAS 1.26:4227) Avail: NTIS HC A13/MF A01 CSCL 22B

The Thermal Protection System (TPS), introduced by NASA, continues to incorporate many of the advances in materials over the past two decades. A comprehensive, single-volume summary of the TPS, including system design rationales, key design features, and broad descriptions of the subsystems of TPS (E.g., reusable surface insulation, leading edge structural, and penetration subsystems) is provided. Details of all elements of TPS development and application are covered (materials properties, manufacturing, modeling, testing, installation, and inspection). Disclosures and inventions are listed and potential commercial application of TPS-related technology is discussed. Author

24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

For ceramic materials see *27 Nonmetallic Materials*.

N89-26047 Bath Univ. (England).
CORROSION BEHAVIOUR OF METAL MATRIX COMPOSITE Ph.D. Thesis
T. Otani 1988 367 p
Avail: Univ. Microfilms Order No. BRDX83742

The structure and corrosion behavior in deaerated 3.5 pct sodium chloride solution of metal matrix composites (MMCs) of aluminum and Al-Si alloy incorporating fibers made from alumina, silicon carbide, carbon and Borsic were investigated. The MMCs were fabricated by a liquid metal infiltration process and used in the as-fabricated condition. A double cycle polarization (DCP) method was developed as an accelerated corrosion test method and its usefulness was confirmed by a study of the corrosion of unreinforced metals. Evidence is presented which shows that the DCP method is useful one for rapidly assessing corrosion behavior of MMCs, although further work is needed. In aluminum based composites, iron, introduced as in impurity during fabrication, forms FeAl6 compound and tends to segregate at the interface between the fiber and the matrix and at grain boundaries. In Al-Si alloy based composites, silicon tends to segregate at the fiber-matrix interface. This segregation effect is not due to the presence of fibers but results from the rejection of solute ahead of the solidification front during the casting process. The presence of fibers affects matrix microstructure by modifying grain growth and eutectic growth. Chemical reaction between fiber and matrix was not observed. The corrosion of all MMCs, except for carbon reinforced composites, was dominated by microgalvanic corrosion between the aluminium matrix and second phases, the FeAl6 phase in aluminium based composites and silicon in Al-Si alloy based composites. Corrosion attack of fibers was not observed. The effect of fibers on corrosion is secondary, by acting as physical barriers to pit progagation. Carbon fibers form galvanic couples with the aluminum matrix and accelerate corrosion. Dissert. Abstr.

N89-26048*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SIMPLIFIED PROCEDURES FOR DESIGNING ADHESIVELY BONDED COMPOSITE JOINTS
C. C. Chamis and P. L. N. Murthy Feb. 1989 15 p Presented at the 44th Annual Conference of SPI Composites Inst., Dallas, TX, 6-10 Feb. 1989
(NASA-TM-102120; E-4899; NAS 1.15:102120) Avail: NTIS HC A03/MF A01 CSCL 11D

Procedures for the preliminary design of composite adhesive joints are described. Typical joints, their respective free body diagrams, and approximate equations for estimating the stresses in each of these typical joints are summarized. Equations are also presented to check the critical conditions of the joint such as minimum length, maximum adhesive shear stress, and peel-off stress. To illustrate the procedure, sample designs are described in step-by-step fashion for a butt joint with single doubler subjected to static loads, cyclic loads, and environmental effects. The results show that unsymmetric adhesive joints are inefficient and should be avoided, and hygrothermal environments and cyclic loads dramatically reduce the structural integrity of the joint and require several joint lengths compared with those for static load with no environmental effects. Author

N89-26049*# Electrofusion Corp., Fremont, CA.
HIGH TEMPERATURE BE PANEL DEVELOPMENT
R. Hardesty, M. Jensen, and L. Grant May 1989 22 p
(Contract NAS1-18613)
(NASA-CR-181777; L-11737; NAS 1.26:181777) Avail: NTIS HC A03/MF A01 CSCL 11D

Beryllium materials have been used for many aerospace applications over the years. Most of these applications have been fairly ambient environments. The possibility of fabricating beryllium panels for high temperature applications up to 1200 F is investigated. Joining alloys were reviewed, tested and evaluated for high temperature applications. Author

N89-26050*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MATERIALS DIVISION RESEARCH AND TECHNICAL ACCOMPLISHMENTS FOR FY 1988 AND PLANS FOR FY 1989
Kay L. Brinkley Apr. 1989 126 p
(NASA-TM-101593; NAS 1.15:101593) Avail: NTIS HC A07/MF A01 CSCL 11D

The research program of the Materials Division is presented as FY-88 accomplishments and FY-89 plans. The accomplishments for each Branch are highlighted and plans are outlined. Publications of the Division are included by Branch. This material is useful in program coordination with other government organizations, universities, and industry in areas of mutual interest. Author

N89-26051# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
ANALYSIS OF LAMINATED COMPOSITE PLATES USING HYBRID-STRESS ELEMENTS
Liangbo Deng 5 Jan. 1989 15 p Transl. into ENGLISH from Lanzhou Daxue Xuebao (Peoples Republic of China), v. 24, no. 1, 1988 p 15-21
(AD-A206783; FTD-ID(RS)T-1035-88) Avail: NTIS HC A03/MF A01 CSCL 11/4

Based on the modified complementary energy principle, the paper describes a hybrid-stress rectangular flexural element suitable for characteristics of laminated fiber composite plates. This element can take into account the effects of transverse shear deformation and local warping. In the dynamic analysis, the interior element displacements are assumed to be compatible with the boundary displacements. The element has the characteristics of fewer degrees of freedom, convenience in application, and high accuracy in numerical calculations. GRA

N89-26052# Naval Ship Research and Development Center, Bethesda, MD. Ship Materials Engineering Dept.
CALIBRATION OF IMPULSE TECHNIQUE EXPERIMENTAL SET-UP FOR DETERMINATION OF DAMPING LOSS FACTOR
Roger M. Crane Mar. 1989 44 p
(AD-A206797; DTRC-SME-89/12) Avail: NTIS HC A03/MF A01 CSCL 11/4

Composite materials are currently being considered for numerous Naval applications. Among their many advantages, their

inherent vibration damping characteristics is becoming a dominant design consideration. To date, however, there are no analytical techniques which have the capability of predicting the damping loss factor of a particular composite system. One is therefore limited to experimental determination of the damping loss factor for composite materials which requires a high degree of accuracy and precision. An experimental apparatus has been designed, fabricated and tested using 2024 T-4 aluminum as a calibration material. This material has been well characterized in regard to its damping loss factor. Of critical importance is the material placed between the clamping block and the specimen. These materials act to distribute the load and to minimize frictional losses. Various materials were investigated. GRA

N89-26053# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.
INTERACTIONS OF ULTRASONIC WAVES WITH COMPOSITE PLATES Final Report, Dec. 1985 - Dec. 1988
Adnan H. Nayfeh 24 Mar. 1989 65 p
(Grant AF-AFOSR-0052-86; AF Proj. 2306)
(AD-A206991; AFOSR-89-0462TR) Avail: NTIS HC A04/MF A01 CSCL 11/4

We present a unified analytical treatment of the interaction of ultrasonic waves with single and multilayered arbitrarily oriented anisotropic elastic plates. The individual components forming the plate are allowed to possess up to as low as monoclinic symmetry. The plates are assumed to be immersed in a fluid and subjected to incident acoustic waves at arbitrary angles from the normal as well as at arbitrary azimuthal angles. Reflection and transmission coefficients are derived from which all propagation characteristics are identified. Highly complex reflection behavior, expressed as phase velocity-frequency dispersion, is observed as a consequence of anisotropy. Extensive comparisons with the concurrently acquired experimental data by Chimenti at the AFWAL on a variety of composite samples have been of unique help in assessing the validity of our theoretical modeling, and its potential application in the nondestructive evaluation of materials. GRA

N89-26054 Department of the Air Force, Washington, DC.
SILICON NITRIDE WHISKER REINFORCED GLASS MATRIX COMPOSITES Patent
George K. Layden, inventor (to AF) and Karl M. Prewo, inventor (to AF) 23 Aug. 1988 4 p Filed 24 Feb. 1987
(AD-D014094; US-Patent-4,766,096; US-Patent-Appl-SN-018246)
Avail: US Patent and Trademark Office CSCL 11/4

An improved composite material consisting of silicon nitride whiskers uniformly dispersed through a glass matrix and a method for making the composite which comprises the step of dispersing the whiskers in a suitable liquid and separating off the fines and, optionally, the step of treating the dispersed whiskers with HF. This invention relates to a fiber reinforced structural material. More specifically, this invention relates to a composite structure comprised of high strength silicon nitride whiskers in a glass matrix. Fiber reinforced organic matrix composites are widely used and accepted as structural materials because of their desirable attributes of high strength high modulii and low density. In general, most of these composites comprise an organic polymer matrix, such as an epoxy resin, a polyimide, a polycarbonate, or similar material. The matrices are reinforced with a wide variety of fibers including glass, carbon, graphite and boron. However, even the best of these composites are limited to an operational temperature below about 600 F (300 C). GRA

N89-26055# Oxford Univ. (England). Dept. of Engineering Science.
MODELLING OF THE IMPACT RESPONSE OF FIBRE-REINFORCED COMPOSITES Progress Report No. 5
S. Shah, R. K. Y. Li, and J. Harding 1988 124 p
(OUEL-1730/88; ETN-89-94817) Avail: NTIS HC A06/MF A01

A literature survey on techniques for modeling the mechanical response of fiber reinforced plastics is presented. Attempts to develop a finite element analysis of the stress system in the standard composite tensile specimen and in the loading bars of the tensile impact apparatus are described. Testing techniques for determining transverse impact testing and compressive strength are studied. The results are used to predict the quasi-static tensile strengths of the three woven reinforced carbon glass hybrids for which experimental data are available. ESA

N89-26056*# Wyoming Univ., Laramie. Composite Materials Research Group.
MECHANICAL PROPERTIES OF SEVERAL NEAT POLYMER MATRIX MATERIALS AND UNIDIRECTIONAL CARBON FIBER-REINFORCED COMPOSITES Contractor Report, May 1985 - Oct. 1988
Scott L. Coguill and Donald F. Adams Apr. 1989 320 p
(Grant NAG1-277)
(NASA-CR-181805; NAS 1.26:181805; UW-CMRG-R-88-114)
Avail: NTIS HC A14/MF A01 CSCL 11D

The mechanical and physical properties of three neat matrix materials, i.e., PEEK (polyetheretherketone) thermoplastic, Hexcel F155 rubber-toughened epoxy and Hercules 8551-7 rubber-toughened epoxy, were experimentally determined. Twelve unidirectional carbon fiber composites, incorporating matrix materials characterized in this or earlier studies (with one exception; the PISO(sub 2)-TPI matrix itself was not characterized), were also tested. These composite systems included AS4/2220-1, AS4/2220-3, T500/R914, IM6/HX1504, T300/4901A (MDA), T700/4901A (MDA), T300/4901B (MPDA), T700/4901B (MPDA), APC2 (AS4/PEEK, ICI), APC2 (AS4/PEEK, Langley Research Center), AS4/8551-7, and AS4/PISO(sub 2)-TPI. For the neat matrix materials, the tensile, shear, fracture toughness, coefficient of thermal expansion, and coefficient of moisture expansion properties were measured as a function of both temperature and moisture content. For the unidirectional composites, axial and transverse tensile, longitudinal shear, coefficient of thermal expansion, and coefficient of moisture expansion properties were determined, at room temperature and 100 C. Author

25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

N89-26057*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NEAR HARTREE-FOCK QUALITY GAUSSIAN TYPE ORBITAL BASIS SETS FOR THE FIRST- AND THIRD-ROW ATOMS
Harry Partridge Jan. 1989 227 p Presented at the 3rd North American Chemical Congress and the 195th ACS National Meeting, Toronto, Ontario, 5-11 Jun. 1988
(NASA-TM-101044; A-88314; NAS 1.15:101044) Avail: NTIS HC A11/MF A01 CSCL 07D

Energy-optimized, near Hartree-Fock (NHF) quality Gaussian type orbital (GTO) basis sets are reported for the second-row (Li to Ne) and fourth-row (K to Kr) atoms. The most accurate basis sets reported for the second row are (18s 13p) sets which are with 4 micro E(H) of the numerical Hartree-Fock (NHF) results. For B to Ne basis sets with more than 15s functions are quadruple zeta in the valence space. For the second-row transition metal atoms the (20s 12p 9d) basis sets are triple zeta in the valence space and are approximately equivalent to Clementi and Roetti's accurate Slater type orbital sets. Supplementing the (20s 12p 9d) basis sets optimized for the lowest state with the 4s(2)3d(n) occupation with a diffuse d function gives self-consistent-field energy separations to the 4s(1)3d(n+1) and 3d(n+2) states which are within 100 micro E(H) of the NHF results. The most accurate basis sets for the transition metal atoms are with 30 micro E(H) of the NHF results. In addition, energy optimized sets are reported for He(3P), Li(2P) and Be(3P). Author

N89-26058# National Aerospace Lab., Tokyo (Japan).
A SIMPLIFIED CARS THERMOMETRY FOR PRACTICAL USE
Mitsuo Gomi, Yasuo Watanabe, Kunihisa Eguchi, Yohji Kurosawa, and Yoshikazu Kanai Oct. 1988 26 p In JAPANESE; ENGLISH summary
(NAL-TR-999; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

A new and simple technical method of data acquisition by Coherent Anti-Stokes Raman Spectroscopy (CARS) thermometry was studied. The proposed method provides instantaneous temperature determination with quick measurement of an intensity ratio of N sub 2 CARS spectra by the use of a specially prepared monochromator, two photomultipliers and a data processor including an A/D converter, a circuit for sampling-hold mechanism and a personal computer. This method is capable of providing close to real-time temperature measurements for high rate of laser shot repetition, and the remarkable cost reduction of optical and electronic instruments. The measured results were compared and verified with a thermocouple (less than 1200 K) and the conventional multiplex CARS method (1600 to approximately 2000 K). Various causes of, and their contributions to, the measurement errors introduced into the instruments were evaluated experimentally. Application to a practical burner was made with reasonable results. Author

N89-26059 Department of the Air Force, Washington, DC.
OXYGEN SYSTEM ANALYZER Patent
Ronald D. Holden, inventor (to Air Force), John B. Tedor, inventor (to Air Force), Andrew O. Bergquist, inventor (to Air Force), David S. Moran, inventor (to Air Force), and Mike Eiserer, inventor (to Air Force) 23 Aug. 1988 12 p Filed 8 Jun. 1987
(AD-D014004; US-Patent-4,765,193; US-Patent-Appl-SN-059641; US-Patent-Class-738-659) Avail: US Patent and Trademark Office CSCL 14/2

Test and man rating of an oxygen generation system required analytical methods for evaluating system performance both in the laboratory and on the aircraft. The Oxygen System Analyzer is capable of monitoring four performance variables which include: (1) system gas flow rate, (2) product oxygen concentration, (3) system outlet pressure, and (4) aircraft cabin pressure. The analyzer is a portable tester designed to be used on a frequent basic to ascertain system performance and assure reliability and safety. The device may be used either in preflight system checkout mode or to assess in-flight performance characteristics and compliance with design specifications. The analyzer is packaged in a flight worthy case (20x13x8.5 inches, 31 pounds) and operates from a 12 volt rechargeable power system for 8 to 10 hours. Data is handlogged from digital panel meters. The analyzer is also capable of being adapted to assess system performance for other types of oxygen systems whether onboard aircraft, at sea or at landbased locations. GRA

N89-26060# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
THE EFFECT OF SURFACE IMPURITIES ON THE PERMEATION OF HYDROGEN THROUGH PALLADIUM
Armando Bruno Antoniazzi Dec. 1988 202 p
(UTIAS-329; ISSN-0082-5255) Avail: NTIS HC A10/MF A01

The effect of surface impurities (in particular carbon and sulphur) on the permeation of atomic or molecular hydrogen through a palladium membrane was examined. The elemental coverages on one of the membrane surfaces was measured by in situ Auger spectroscopy. The upstream, driving, pressure for molecular permeation ranged from similar to 10(-5) to 3x10(2) Pa. For atomic permeation the incident sub-eV atomic flux varied from similar to 1x10(15) to 3x10(20) H(o)/m(2).s. The palladium temperature ranged from 355 to 630K. Atomic hydrogen was used to measure the membrane asymmetry in the surface limited permeation regime. The phenomenological recombination rate coefficient, K sub r, and consequently the permeation rates were observed to decrease by a factor of similar to 10(-4) for an increase in the impurity coverage from 0.13 to 0.45. The change observed is compatible with a mechanism which views the reduction in the permeation rate as resulting from a blockage of surface adsorption sites. Molecular sticking coefficients measured at 625K ranged from 3.2x10(-6) to 7.0x10(-2), depending on impurity coverage. Observed permeabilities in the diffusion limited regime were found to be in agreement with literature values. Author

N89-26061*# Eloret Corp., Sunnyvale, CA.
CHEMICAL CALCULATIONS ON CRAY COMPUTERS
Peter R. Taylor, Charles W. Bauschlicher, Jr., and David W. Schwenke 1989 110 p
(Contract NCC2-371)
(NASA-CR-183240; NAS 1.26:183240) Avail: NTIS HC A06/MF A01 CSCL 07D

The influence of recent developments in supercomputing on computational chemistry is discussed with particular reference to Cray computers and their pipelined vector/limited parallel architectures. After reviewing Cray hardware and software the performance of different elementary program structures are examined, and effective methods for improving program performance are outlined. The computational strategies appropriate for obtaining optimum performance in applications to quantum chemistry and dynamics are discussed. Finally, some discussion is given of new developments and future hardware and software improvements. Author

N89-26062# Duke Univ., Durham, NC. Dept. of Chemistry.
DETERMINATION AND INTERRELATION OF BOND HETEROLYSIS AND HOMOLYSIS ENERGIES IN SOLUTION Annual Report, Jan. - Dec. 1988
Edward M. Arnett, K. Amarnath, J. P. Cheng, and N. G. Harvey Feb. 1989 60 p
(Contract GRI-5088-260-1643)
(PB89-173660; GRI-89/0022) Avail: NTIS HC A04/MF A01 CSCL 07D

Heats of homolysis were determined by combining heats of heterolysis, determined mostly under a previous contract, with redox potentials for a variety of resonance-stabilized carbocations and anions by means of a simple thermodynamic cycle. The heats of heterolysis were derived from calorimetrically measured heats if reaction by changing the sign (delta H sub het = -delta H sub rxn). Redox potentials were determined by cyclic voltammetry and a special technique (secondary harmonic alternating current voltammetry (SHACF)) which produced excellent reversible electrochemical data. The difference between delta H sub het and delta H sub homo is the enthalpy of electron transfer, which for the systems studied is approximated closely by the free energy of electron transfer-the difference between the oxidation potential of the carbanion and the reduction potential of the cation. The heats of homolysis and heats of heterolysis determined under the project are the first available thermo-dynamic data for the two primary modes of bond cleavage in solution for the C-C, C-O, C-N, and C-S bonds typically found in coal fragments. GRA

N89-26063# Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).
A STUDY OF FUEL DILUTION OF DIESEL LUBRICATING OIL BY GAS CHROMATOGRAPHY/MASS SPECTROMETRY
J. A. Hiltz, D. E. Veinot, and R. D. Haggett Jan. 1989 31 p
(AD-A206702; DREA-TM-89/203) Avail: NTIS HC A03/MF A01 CSCL 11/8

A method for the detection and identification of fuel components in diesel lubricating oil is described. The method uses a capillary gas chromatograph coupled to a quadrupole mass spectrometer to separate, detect and identify diluents in the oil. A typical analysis takes 40 minutes. Accurate determination of the level of fuel dilution of a diesel lubricating oil sample using Gas Chromatography/Mass Spectroscopy (GC/MS) is shown to be dependent upon a number of factors including the source of the fuel, the age of the fuel, the thermal history of the fuel diluted diesel oil sample and the availability of a suitable sample of fuel to prepare standard response versus concentration curves. GRA

N89-26064# Chemical Research and Development Center, Aberdeen Proving Ground, MD.
RATE CONSTANTS FOR THE REACTION OF PO(V=0) AND PO(V=1) RADICALS WITH OXYGEN Technical Report, Jul. 1985 - Mar. 1986
S. Randolph Long and Steven D. Christesen Jan. 1989 23 p
(AD-A206799; CRDEC-TR-033) Avail: NTIS HC A03/MF A01 CSCL 07/4

Laser-induced fluorescence (LIF) has been used to probe vibrational state population of PO radicals generated by Carbondioxide2 photolysis of dimethyl methylphosphonate. PO radicals in vibrational levels up to v = 3 have been detected. The population ratio determined for v = 0 and v = 1 is consistent with a vibrational temperature of 1000 k. LIP monitoring of the decay of PO radicals in the presence of an excess of oxygen has allowed determination of the rate constants for reaction of PO (v = 0) and PO (v = 1) with o2. The measured rate constants for both these reactions are 1.5 x 10 to the -11 power cc molecule/s or about 1/25 the hard-sphere collision rate. Potential laser photofragmentation/LIF detection schemes for organophosphonates should accordingly incorporate no more than 10 ns between photolysis and probing for PO radicals. GRA

N89-26065# Texas Univ., Austin. Dept. of Chemistry.
DEVELOPMENT OF PRACTICAL MO TECHNIQUES FOR PREDICTION OF THE PROPERTIES AND BEHAVIOUR OF MATERIALS Final Technical Report, 1 Oct. 1985 - 1 Nov. 1988
Michael J. Dewar 26 Jan. 1989 34 p
(Grant AF-AFOSR-0022-86; AF Proj. 2303)
(AD-A206831; AFOSR-89-0242TR) Avail: NTIS HC A03/MF A01 CSCL 20/3

Notable advances in computational procedures include development of AM1 parameters for phosphorus and sulfur, analytical derivatives for treatments including CI, a new and effective procedure for locating transition states, AM1 parameters for boron and silicon. Work has begun on two new semiempirical treatments. There has been a revision of current ideas concerning the mechanisms of pericyclic reactions and an extensive survey of elimination reactions. A novel mechanism for superconductivity has been suggested. GRA

N89-26066# Ultramet, Pacoima, CA.
THIN REFRACTORY FILMS ON FUSED SILICA CRUCIBLES Final Report, Jun. - Dec. 1987
J. G. Sheek and Richard B. Kaplan Jul. 1988 22 p
(Contract F19628-87-C-0144)
(AD-A206909; ULTRAMET-6321-F; RADC-TR-88-148) Avail: NTIS HC A03/MF A01 CSCL 09/1

The ability to control unwanted impurity levels during electronic device fabrication is essential to establishing the desired properties and quality for device reliability. Conventional production processes must be painstakingly monitored to ensure against contamination, and are vulnerable to the introduction of impurities at many stages. One source of impurities is the containment vessel for the melt. In this program, Ultramet demonstrated the feasibility of fabricating inexpensive, high-purity crucibles by an innovative application of Chemical Vapor Deposition (CVD), which typically produces materials with impurity levels of 5 ppm. By depositing thins, pore-free refractory films on the interior surfaces of fused silica crucibles, contamination protection equal to or better than that of expensive monolithic freestanding crucibles can be provided. GRA

N89-26067# SRI International Corp., Menlo Park, CA.
DYNAMICS OF EXCITED HIGH-LYING STATES OF H2 AND D2 Final Report, 5 May 1986 - 4 Oct. 1988
Ravinder Kachru and Hanspeter Helm Nov. 1988 76 p
(Contract F49620-86-K-0017; SRI Proj. PYU-2179)
(AD-A206936; SRI-MP-88-234; AFOSR-89-0474TR) Avail: NTIS HC A05/MF A01 CSCL 07/2

The spectroscopy and dynamics of Rydberg states of molecular hydrogen is important in modeling discharge and electron beam pumped lasers, molecular ion electron collisions, and the photoionization of molecular hydrogen. Our primary objective was to investigate the excited states of H2 and D2 as two prototypes for a systematic study of manifestations of the static and dynamic interactions governing molecular Rydberg states. Our experimental approach employed a stepwise laser excitation scheme. Detection of the charged molecular, atomic fragments and the energy-analyzed electrons enabled us to measure autoionization, ionization, dissociation, and the competition between them. We studied and analyzed the np autoionizing Rydberg states in H2. We also studied the competition between photoionization and photodissociation from the C1IIuH2 state. In addition, we performed the first study of the onset of field ionization and the forced rotational autoionization of the np Rydberg states. We demonstrated that the ionization process can be described classically. GRA

N89-26068# Rensselaer Polytechnic Inst., Troy, NY. Dept. of Chemistry.
PREPARATION OF SiC/AIN SOLID SOLUTIONS USING ORGANOMETALLIC PRECURSORS Final Scientific Report, 30 Sep. 1985 - 31 Dec. 1988
L. V. Interrante 15 Feb. 1989 15 p
(Contract F49620-85-K-0019)
(AD-A206998; AFOSR-89-0384TR) Avail: NTIS HC A02/MF A01 CSCL 07/1

The co-pyrolysis of organoaluminum and organosilicon compounds was investigated as a potential source of SiC/AIN solid solutions. Using two different co-pyrolysis methods, homogeneous mixture of organoaluminum amides and both a vinylic polysilane and a polycarbosilane were converted to a pre-ceramic solid that transformed to crystalline Sic/AIN solid solutions at greater than 1600 C. Moreover, the liquid, polymeric, form of these precursor mixtures provides a potential processing advantage that may be useful for ceramic matrix preparation and other applications. In the course of this work new precursors to both AIN and SiC were identified and their structures and pyrolysis reactions were investigated, providing useful information regarding structure/pyrolysis chemistry relationships for such precursor systems. In addition, modifications of this co-pyrolysis approach to SiC/AIN solid solutions were employed to obtain mixed-phase SiC/AIN solid solutions were employed to obtain mixed-phase SiC/AIN, silicon nitride, silicon nitride/ALN and Beta-SiAlON ceramics. The composition, phase distribution, microstructure of these ceramics were examined by elemental analysis, X-ray powder diffraction, SRM/TEM, and other methods. GRA

N89-26069# Purdue Univ., West Lafayette, IN. Dept. of Chemistry.
ASYNCHRONOUS OPTICAL SAMPLING FOR LASER-BASED COMBUSTION DIAGNOSTICS IN HIGH-PRESSURE FLAMES Final Report, 15 Dec. 1988 - 31 Jan. 1989
Galen B. King, Normand M. Laurendeau, and Fred E. Lytle 28 Feb. 1989 21 p
(Grant AF-AFOSR-0323-84; AF Proj. 2308)
(AD-A207003; AFOSR-89-0410TR) Avail: NTIS HC A03/MF A01 CSCL 21/2

This report describes progress on the development of a new laser-based combustion diagnostic for the quantitative measurement of both major and minor species in high pressure flames. The technique, Asynchronous Optical Sampling (ASOPS), is a state-of-the-art improvement in picosecond pump/probe spectroscopy. The timing parameters for the current ASOPS instrument are described and consideration is given to the optimization of these parameters. Results from the study of the sodium atom in an atmospheric flame are presented. Instrumental changes are shown that considerably improve the ASOPS signal-to-noise ratio. A technique for optimization of ultra violet generation is demonstrated and initial hydroxyl fluorescence experiments are described. GRA

N89-26070# North Carolina Univ., Chapel Hill. Dept. of Chemistry.
ON 1,2-DIFLUOROBENZENE: AN INERT, NON-COORDINATING SOLVENT FOR ELECTROCHEMICAL STUDIES ON TRANSITION METAL COMPLEXES
Terrence R. OToole, Janet N. Younathan, B. Patrick Sullivan, and Thomas J. Meyer 1989 22 p Submitted for publication
(Contract N00014-87-K-0430)
(AD-A207007; TR-6) Avail: NTIS HC A03/MF A01 CSCL 07/4

1,2-Difluorobenzene (DFB) is shown to be a useful solvent for electrochemical studies on transition metal complexes. Because DFB is non-coordinating and relatively inert chemically, it can be a useful solvent for generating and stabilizing otherwise inaccessible intermediates. The accessible potential range for electrochemical studies DFB extends from plus 2.0V to minus 2.2V vs ssce. GRA

N89-26071# Utah Univ., Salt Lake City. Dept. of Materials Science and Engineering.
FLUCTUATION ANALYSIS OF LIQUID/LIQUID AND GEL/LIQUID INTERFACES Interim Report
Vladimir Marecek, Miklos Gratzl, Angras Pungor, and Jiri Janata 17 Mar. 1989 37 p
(Contract N00017-87-K-0060)
(AD-A207088) Avail: NTIS HC A03/MF A01 CSCL 07/4

Voltage fluctuations resulting from transfer of ions at liquid/liquid and gel/liquid interfaces were analyzed. For frequencies higher than the range 6 to 60 Hz the power spectra were not influenced by the presence of picrate ions in the solution to any major extent. In this range, the resistivity was found to be approximately proportional to the inverse frequency square, both in absence and in the presence of picrate. By using an equivalent circuit approach, the effect of the cell geometry on the resulting power spectra was examined. GRA

N89-26072 Department of the Air Force, Washington, DC.
CHEMICAL COMPOSITION FOR THE DESTRUCTION OF MICROFILM PRODUCTS Patent
Judith F. Kitchens, inventor (to Air Force), Carl H. Culp, Sr., inventor (to Air Force), and Anthony T. Shemonski, inventor (to Air Force) 30 Aug. 1988 6 p Filed 4 Feb. 1980
(AD-D014082; US-Patent-4,767,564; US-Patent-Appl-SN-116132; US-Patent-Class-252-187.26) Avail: US Patent and Trademark Office CSCL 05/2

This invention relates to the destruction of microform materials, especially those of a confidential or classified nature. More particularly, this invention concerns itself with a chemical mixture or destruction solution for effecting the rapid destruction of microform materials. In accordance with the present invention, it was found that a chemical mixture composed of 4-butyrolactone, methyl Cellosolve acetate and aqueous sodium hypochlorite having an optimum formulation of about 25 volume percent methyl Cellosolve acetate; about 37 volume percent Am-chlor; and 13 volume percent water provides an optimum destruct solution. Am-chlor is a tradename of a 12.5 percent sodium hypochlorite solution distributed by Amchlor Corporation Pool Chemical Division of Amato Solvents, Inc. Silver Spring, Md. The chemical destruct mixture can be incorporated in any type of destruction box, safe or other container or any type of destruction box, safe or other container or system used to destroy classified or sensitive documents. The safe can be used for both storage and destruction of classified film. GRA

N89-26073# Technische Univ., Eindhoven (Netherlands).
ZINC ELECTRODE SHAPE CHANGE Ph.D. Thesis
Robert Eduard Franci Einerhand 1989 186 p
(ETN-89-94875) Avail: NTIS HC A09/MF A01

Hydrogen production during the electrodeposition of zinc from alkaline zincate solutions; the role of metal-oxide additives on the kinetics of the electrodissolution of zinc; shape change in cells of different geometry, and in situ monitoring of zinc electrode shape change; and the density gradient model were studied. ESA

N89-26074# Technische Univ., Eindhoven (Netherlands).
SELECTIVITY IN ANALYTICAL ISOTACHOPHORESIS Ph.D. Thesis
Antonius Adrianus Ge Lemmens 1989 177 p
(ETN-89-94878) Avail: NTIS HC A09/MF A01

Selectivity in isotachophoretic (ITP) separation, automatic signal processing, and analytical applications are discussed. The suitability of ITP as a reference method was investigated for the determination of sodium in human serum. Aspects of sample pretreatment prior to ITP analysis are discussed. The ITP separation of alkali and alkaline earth metals was investigated. Experiments show high recovery of potassium, sodium, magnesium, calcium, strontium, barium, and lead with high accuracy. The possibilities of preparative ITP as a sample pretreament technique prior to HPLC analysis are discussed. ESA

N89-26075# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Lampoldshausen (West Germany). Inst. fuer Chemische und Verfahrenstechnik.
THEORETICAL INVESTIGATION OF DIFFUSION FLAME STABILIZATION OVER A RECIRCULATING FLOW Ph.D. Thesis - Bielefeld Univ.
Matthias Konczalla Jan. 1989 124 p In GERMAN; ENGLISH summary
(DFVLR-FB-89-02; ISSN-0171-1342; ETN-89-94978) Avail: NTIS HC A06/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 44

The stabilization of a diffusion flame over a recirculating flow downstream of a backward-facing step is investigated. An Arrhenius expression is introduced into the conservation equations to describe the reaction. The activation energy of the reaction is used as the larger parameter in a singular perturbation approach. A well-defined singularity determines an ignition point on the dividing streamline. Downstream from this ignition point a flame is observed. Using Linan's premixed flame analysis, an equation for the flame surface is derived. It is shown that only up to a well-defined value of the entrance velocity, the flame penetrates the mixing layer over the wake. ESA

N89-26346*# Indiana Univ., Bloomington. Biogeochemical Labs.
ISOTOPE RATIO MONITORING GAS CHROMATOGRAPHY MASS SPECTROMETRY (IRM-GCMS) Abstract Only
K. H. Freeman, S. A. Ricci, A. Studley, and J. M. Hayes *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 20-21 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 07D

26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

N89-26076 Columbia Univ., New York, NY.
CREEP-FATIGUE BEHAVIOR OF DIRECTIONALLY SOLIDIFIED AND SINGLE NICKLE-ALUMINIDE INTERMETALLIC Ph.D. Thesis
Richard Scott Bellows 1988 83 p
Avail: Univ. Microfilms Order No. DA8827537

The creep-fatigue behavior of Ni3Al(B,Hf), an ordered nickel-aluminide intermetallic, is investigated using a modified fatigue test that inversely varies the stress range and mean stress. The test matrix allows the cyclic (fatigue) and mean stress (creep) effects to be examined simultaneously. Stress range versus cycles-to-failure (S-N) curves and dynamic creep (envelope strain) curves are generated and examined. Directionally solidified (D.S.) and single crystal (S.C.) forms of the intermetallic are used to reduce the number of transverse grain boundaries, and thus minimize the associated grain boundary effects. The three regimes investigated represent above, near, and below the peak yield strength temperature of approximately 760 C. The addition of

thermally activated processes, or creep, cause the S-N curves to invert at higher mean stress levels. At 982 C, albeit the 0.2 percent yield strength and ultimate tensile strength (UTS) are low, the relative creep-fatigue resistance is high, possibly as a result of a dynamically generated pinning mechanism. At 760 C, the peak temperature for yield strength and UTS, the creep-fatigue resistance, which is attributed to the highly ordered lattice inducing homogeneous slip, is found to be superior to that of a conventional wrought nickel-base superalloy. At 450 C, the yield strength is low with respect to 760 C, but the creep-fatigue resistance and UTS remains high. Thus, the creep-fatigue resistance emerges as a function of the UTS, not yield strength, indicating the importance of work hardening at this temperature. Coplanar cracking along (111) slip bands and TEM results are indicative of intensely planar slip at lower temperatures. At higher temperatures, slip becomes more wavy, although fracture is still crystallographic. Decohesion of parallel grain boundaries limited the lifetimes of several specimens. Dissert. Abstr.

N89-26077# Bureau of Mines, Albany, OR. Research Center.
VACUUM INDUCTION MELTING OF Ti-6Al-4V IN A COLD CRUCIBLE: REPORT OF INVESTIGATIONS
J. I. Paige May 1988 13 p
(PB89-159784; BM-RI-9211; LC-88-600280) Avail: NTIS HC A03/MF A01 CSCL 11F

The effect of fluoride inclusions on the properties of titanium produced from the Bureau of Mines-developed induction slag melting process is of concern to the titanium industry. The objective was to determine the effect of removing the nonconductive molten calcium fluoride (CaF2) slag used as an insulator between the titanium and the segmented copper crucible. The data were obtained from single-induction-melted ingots prepared with no CaF2 insulating slag and an ingot prepared with the normal addition of 4 pct CaF2 slag. The results showed that the mechanical properties of single-induction-slag-melted and annealed Ti-6Al-4V alloy exceed the minimum values specified in Aerospace Materials Specification for Titanium Alloy Bars and Forgings AMS4928H. High-cycle, tension-tension fatigue testing yielded similar results. The data from 44 of the 45 specimens were contained within the typical scatter band for fatigue data on wrought Ti-6Al-4V alloy. Although the removal of the insulating slag is a desirable change, the data from the specimens with the previously standard 4 pct slag addition showed no detrimental effect from the slag inclusions. Author

N89-26078*# Battelle Columbus Labs., OH.
FABRICATION OF Pd-Cr WIRE Final Report
Sidney Diamond and Dennen M. Leach Jul. 1989 27 p
(NASA Order-C-02999-J)
(NASA-CR-182304; NAS 1.26:182304) Avail: NTIS HC A03/MF A01 CSCL 11F

Fabrication of Pd-13 percent Cr alloy wires is described. Melting, casting, swaging and annealing processes are discussed. Drawing to reach two diameters (0.003 inch and 0.00176 inch) of wire is described. Representative micrographs of the Pd-Cr alloy at selected stages during wire fabrication are included. The resistance of the wire was somewhat lower, by about 15 to 20 percent, than comparable wire of other alloys used for strain gages. K.C.D.

N89-26079*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE CORROSION PROTECTION OF ALUMINUM BY VARIOUS ANODIZING TREATMENTS
Merlin D. Danford Apr. 1989 48 p
(NASA-TM-100366; NAS 1.15:100366) Avail: NTIS HC A03/MF A01 CSCL 11F

Corrosion protection to 6061-T6 aluminum, afforded by both teflon-impregnated anodized coats (Polylube and Tufram) and hard-anodized coats (water sealed and dichromate sealed), was studied at both pH 5.5 and pH 9.5, with an exposure period of 28 days in 3.5 percent NaCl solution (25 C) for each specimen. In general, corrosion protection for all specimens was better at pH 9.5 than at pH 5.5. Protection by a Tufram coat proved superior to that afforded by Polylube at each pH, with corrosion protection by the hard-anodized, water-sealed coat at pH 9.5 providing the best protection. Electrochemical work in each case was corroborated by microscopic examination of the coats after exposure. Corrosion protection by Tufram at pH 9.5 was most comparable to that of the hard-anodized samples, although pitting and some cracking of the coat did occur. Author

N89-26080# Wyman-Gordon Co., Worcester, MA.
STUDY OF THE INFLUENCE OF METALLURGICAL FACTORS ON FATIGUE AND FRACTURE OF AEROSPACE STRUCTURAL MATERIALS Final Report, 1 Jan. 1986 - 31 Dec. 1988
James Lankford, David L. Davidson, Kwai S. Chan, and Gerald R. Leverant 1 Mar. 1989 35 p
(Contract F49620-86-C-0024)
(AD-A206605; AFOSR-89-0400TR) Avail: NTIS HC A03/MF A01 CSCL 01/3

Direct SEM measurement of closure local to crack tips in several structural alloys was performed. Growth rates for both large and small cracks in an aluminum alloy, a nickel-base superalloy, and an intermetallic alloy were correlated by formulating correctly the crack driving force. It was determined that apparent differences in crack growth rates under varying circumstances, including variable amplitude loading, were caused not by differences in the intrinsic crack advance mechanism, but rather by inaccuracies in determining the proper transfer function between the conventional cyclic stress intensity, and the true local crack driving force. The relationship between microstructure and fracture toughness was investigated for state-of-the-art Al-Fe-X alloys. Relevant fracture mechanisms and origins of fracture toughness were identified, and analyzed in terms of microstructural factors (dispersoids and oxide fragments). The origin of the brittle-to-ductile transition in Al-Fe-X was identified, and shown to be controlled by the tearing modulus. Concepts for increasing toughness were established. GRA

N89-26081# Stanford Univ., CA. Solid State Electronics Lab.
STUDIES OF INTERFACIAL CHEMISTRY BETWEEN METALS AND THEIR EFFECT ON ELECTRONIC SYSTEMS Final Report, 1 Oct. 1986 - 30 Sep. 1988
W. E. Spicer and I. Lindau 30 Sep. 1988 29 p
(Contract N00014-83-K-0073; ARPA Order 5674; NR Proj. 4147126-02)
(AD-A206632) Avail: NTIS HC A03/MF A01 CSCL 09/1

The interfacial chemistry of the metal/III-V semiconductor systems and their influence on electronic properties of interfaces were studied. The study was concentrated on GaAs and to a lesser extent InP - two representative III-V semiconductors of foremost technological interest. Also included were studies of oxidation (partly because of the presence of oxides at interfaces of practical devices) and studies of III-V semiconductor heterojunctions (which are very closely related to the problems investigated in this proposal). Also, some amendments of the program were implemented to touch on current developments in the field of III-V semiconductor interfaces. A broad range of laboratory techniques were used with particular emphasis on photoemission spectroscopy for thin overlayers and I-V and C-V electrical measurements for thick metallic overlayers. GRA

N89-26082# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
EVALUATION OF THE MECHANICAL PROPERTIES OF 2091 AND 8090 ALLOYS Final Report, 1 Feb. 1987 - 30 Sep. 1988
Mary E. Donnellan 21 Sep. 1988 31 p
(NADC Proj. RS-3-4-A50)
(AD-A206785; NADC-88097-60) Avail: NTIS HC A03/MF A01 CSCL 11/6

This investigation was performed as part of an ongoing evaluation program by the Naval Air Development Center on advanced aluminum-lithium alloys. The Navy has considerable interest in aluminum-lithium alloys for aerospace applications. It is well known that the addition of lithium to aluminum decreases the density and increases the modulus of aluminum alloys. Due to

these properties there may be significant weight savings achieved by using aluminum-lithium alloys in aircraft structure. The objective of this study was to evaluate the mechanical properties of two aluminum-lithium alloys, 2091-T351 and 8090-T651. Both of these alloys are being considered as medium strength replacements for 2024. The 8090 alloy is desirable because it exhibits a lower density with improved static strength properties than those of 2024. Direct replacement of 2024 with 8090 would result in a 10 percent weight reduction because of the lower density. The 2091 alloy is attractive because it exhibits a lower density with improved strength, toughness and ductility over that of 2024. GRA

N89-26083# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
PRIMERLESS FINISHING SYSTEMS FOR THE CORROSION PROTECTION OF ALUMINUM Final Report, Oct. 1987 - Sep. 1988
Donald J. Hirst, Charles R. Hegedus, Stephen J. Spadafora, and Anthony T. Eng 19 Sep. 1988 36 p
(AD-A206893; NADC-88107-60) Avail: NTIS HC A03/MF A01 CSCL 11/3

A trend to develop primerless systems for military equipment has begun in which a topcoat can be applied directly to surface treated aluminum. Two approaches to obtain a primerless system are currently available and were investigated. In the first approach, a standard sulfuric acid anodized surface was sealed with a polyurethane colloidal suspension. The resulting pretreatment can be directly topcoated. The second approach involved the application of a primerless or self-priming topcoat applied directly to a surface pretreatment. Adhesion, electrochemical impedance spectroscopy, flexibility and corrosion resistance tests were performed on several aluminum substrates to determine the physical properties of the coating-pretreatment systems. The results of this analysis indicate that these primerless systems show promise and should be considered for specific finishing system applications. GRA

N89-26084# Illinois Univ., Urbana. Dept. of Materials Science and Engineering.
Al AND Mg ALLOYS FOR AEROSPACE APPLICATIONS USING RAPID SOLIDIFICATION AND POWDER METALLURGY PROCESSING Final Technical Report
Hamish L. Fraser 28 Mar. 1989 99 p
(Grant AF-AFOSR-0191-85; AF Proj. 2306)
(AD-A207085; AFOSR-89-0401TR) Avail: NTIS HC A05/MF A01 CSCL 11/6

The work performed during the past three years has involved studies of some elevated temperature Aluminum and Magnesium alloys, and in addition a preliminary study of intermetallic compounds based on Al3X, where X is Ti, V, and Ni+Ti. In the case of the AL alloys, this work was in essence a continuation of the work performed during the preceeding three years of study, where Rapid Solidification Processing (RSP) of AL alloys was investigated. Two areas were investigated, one involving alloys which might exhibit high elastic moduli, and the second concerned the improvement in fracture toughness when Si is added to AL-Fe-Mo alloys. It was found that the modulus increases AL-Be alloys processed by rapid solidification were as expected from theory, whereas those for AL-Mn alloys were somewhat below expectation. This latter result was attributed to casting porosity present in our samples. In terms of the AL-8Fe-2Mo-Si alloys (where both 0.5 percent and 1.0 percent si have been added), the development of microstructure following RSP has been studied in alloys with, and without, the Si additions. The presence of Si resulted in the information of the compound alpha-ALFeSi, with space group determined to be Im3 by convergent beam electron diffraction. The morphology of the precipitates of this compound were found to be approximately spherical and when compared with the lenticular precipitates in the case of consolidated Al-8Fe-2Mo, this shape is thought to account for the difference in fracture toughness results. GRA

N89-26085# Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
ADVANCED PROCESSING AND PROPERTIES OF HIGH PERFORMANCE ALLOYS Technical Report, 1 Jan. - 31 Dec. 1988
D. A. Koss Apr. 1989 33 p
(Contract N00014-86-K-0381)
(AD-A207117; TR-12) Avail: NTIS HC A03/MF A01 CSCL 11/6

Progress is reviewed for a research program whose purpose is to establish a broad-based understanding of the application and consequences of advanced processing techniques, especially as they influence the strength and fracture resistance of high performance structural alloys. While some of the research is specific to certain alloy systems, much of the program constitutes fundamental study of the deformation and fracture of engineering alloys containing processing-induced defects. Progress for the period January 1, 1988, to December 31, 1988, is reviewed for the following projects within the program. The influence of porosity on low cycle fatigue, the mechanism of strain-induced void/pore linking during ductile fracture, and the processing and properties of CU-NB micro-composites are discussed. GRA

N89-26086# Pennsylvania State Univ., University Park. Dept. of Materials Science and Engineering.
HIGH TEMPERATURE OXIDATION STUDIES ON ALLOYS CONTAINING DISPERSED PHASE PARTICLES AND CLARIFICATION OF THE MECHANISM OF GROWTH OF SiO2 Final Report, 15 Aug. 1985 - 31 Dec. 1988
R. Yan, B. Munn, and G. Simkovich 14 Feb. 1989 29 p
(Grant AF-AFOSR-0298-85; AF Proj. 2306)
(AD-A207161; AFOSR-89-0392TR) Avail: NTIS HC A03/MF A01 CSCL 11/6

In most binary transition metal alloys, additions of Cr are used to promote the formation of a protective cr2O3 layer. Once formed, this layer acts as a barrier between the metal and its environment and, thereby, prolongs service life of the alloy. The ability to form such a layer depends upon a complex interaction of variables; the most influential being the concentration of Cr present in the alloy. In fact, there is a critical concentration of Cr, below which a complete, protective CR2O3 scale will not form. Under the severe conditions employed in this investigation, upwards of 18 weight percent Cr is required to form a protective layer in the binary Ni-Cr and Fe-Cr alloys. GRA

N89-26087 Department of the Air Force, Washington, DC.
METHOD OF PRODUCING TITANIUM ALUMINIDE METAL MATRIX COMPOSITE ARTICLES Patent
Francis H. Froes, inventor (to Air Force) and Daniel Eylon, inventor (to Air Force) 24 May 1988 5 p Filed 12 Feb. 1987
(AD-D014091; US-Patent-4,746,374; US-Patent-Appl-SN-013817)
Avail: US Patent and Trademark Office CSCL 11/4

A method is presented for fabricating an improved titanium alloy composite. It consists of at least one high strength/high stiffness filament or fiber embedded in a titanium-aluminum base alloy matrix which comprises the steps of providing a rapidly-solidified foil made of the titanium-aluminum base alloy, fabricating a preform consisting of alternating layers of the rapidly-solidified foil and the filamentary material, and applying heat and pressure to consolidate the preform, wherein consolidation is carried out at a temperature below the beta-transus temperature of the alloy. GRA

N89-26088 National Physical Lab., Teddington (England). Div. of Materials Application.
EFFECT OF TEMPERATURE AND H2S CONCENTRATION ON HYDROGEN DIFFUSION AND TRAPPING IN A 13 PERCENT CHROMIUM MARTENSITIC STAINLESS STEEL IN ACIDIFIED NaCl
A. Turnbull and M. W. Carroll Dec. 1988 24 p
(NPL-DMA(A)-172; ISSN-0143-7313; ETN-89-94822) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW17 0LW, United Kingdom

The hydrogen uptake and trapping characteristics are determined as a function of temperature (23 to 77 C) and H2S content of acidified solutions of NaCl. The permeation transients are undertaken using a diffusion trapping model which incorporates both reversible and irreversible trapping with varying degrees of occupancy. The density of reversible trap sites is found to be independent of temperature and is 2.3 times 10 to the 19th power site/cc. Evaluation of the charging time for slow strain rate specimens suggests a factor of two decrease in charging time when the temperature is increased from 23 to 77 C. ESA

N89-26089 Technische Univ., Delft (Netherlands).
AGING OF LIQUID-QUENCHED AND SOLID-QUENCHED ALUMINUM BASE ALLOYS; ANALYSIS OF LATTICE-PARAMETER VARIATIONS Ph.D. Thesis
Piet vanMourik 1988 104 p
(ISBN-90-6275-488-0; ETN-89-94890) Copyright Avail: Delft Univ. Press, Stevinweg 1, 2628 CN Delft, Netherlands

Structures of liquid-quenched alloys; X-ray diffraction line shift and line broadening due to misfit strains in two-phase alloys; and precipitation and the development and relaxation of misfit strains in liquid-quenched and in solid-quenched AlSi and AlMg alloys were studied. ESA

N89-26090# Technische Univ., Delft (Netherlands). Lab. of Metallurgy.
RAPIDLY SOLIDIFIED ALUMINUM ALLOYS: THE PRECIPITATION BEHAVIOR AND THE MECHANICAL PROPERTIES AFTER COMPACTION Ph.D. Thesis
Maarten vanRooyen 1988 93 p Sponsored in pary by the Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam, Netherlands and Science Technology Foundation, Netherlands
(ETN-89-94891) Avail: NTIS HC A05/MF A01

Morphology, microstructure, and precipitation behavior of melt-spun AlMg and AlSi-alloys; and mechanical properties of rapidly solidified aluminum alloys after hot compaction were studied. ESA

27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials.*

N89-26091*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
REACTION OF PERFLUOROALKYLPOLYETHERS (PFPE) WITH 440C STEEL IN VACUUM UNDER SLIDING CONDITIONS AT ROOM TEMPERATURE
Shigeyuki Mori (Iwate Univ., Morioka, Japan) and Wilfredo Morales Jan. 1989 12 p
(NASA-TP-2883; E-4209; NAS 1.60:2883) Avail: NTIS HC A03/MF A01 CSCL 07D

Reactions of perfluoroalkylpolyethers (PFPE: Fomblin, Demnum and Krytox) were studied during the sliding contact of stainless steel specimens under ultrahigh vacuum conditions. All three fluids reacted with the steel specimens during sliding. Fomblin, which has acetal linkages, decomposed under the sliding conditions generating gaseous products, (COF2 and fluorinated carbons) which were detected by a quadrupole mass spectrometer. Gaseous products were not detected for the Demnum and Krytox fluids. The amount of gaseous products from Fomblin increased with increasing sliding speed. At the end of the sliding experiments, the wear scar and deposits on the specimens were examined by small spot size XPS. The oxide layer on the specimen surface was removed during sliding, and metal fluorides were formed on the worn surface. The surface of the wear scar and deposits were covered with adsorbed PFPE. Based on these results, it was concluded that the decomposition reaction on Fomblin was initiated by contacting the fluid with a fresh metal surface which was formed during sliding. Author

N89-26092# National Inst. of Standards and Technology, Gaithersburg, MD. Building Materials Div.
RELATIONSHIP BETWEEN APPEARANCE AND PROTECTIVE DURABILITY OF COATINGS: A LITERATURE REVIEW
T. Nguyen, B. Collins, L. Kaetzel, J. Martin, and M. McKnight Dec. 1988 57 p Sponsored by Naval Civil Engineering Lab., Port Hueneme, CA
(PB89-162598; NISTIR-88/4010) Avail: NTIS HC A04/MF A01 CSCL 11C

For coatings, improved service life prediction aids in the effective selection and use of materials and in the development of cost-effective maintenance strategies. However, quantitative measures of degradation are essential in predicting service life. Standard procedures are available to quantitatively measure small changes in the appearance properties of coatings, one of the two primary functions of coatings, the other being protection. However, quantitative measurements of early changes associated with the protective function usually are not possible. It is ascertained, based upon the literature, whether changes in appearance properties of coatings can be used to predict changes in the protective properties of the film. It is concluded, that for the most part, changes in appearance properties are not related to changes in the protective properties of a coating film. Author

N89-26093 Department of the Air Force, Washington, DC.
IN SITU BETA ALUMINA STRESS SIMULATOR Patent
John F. Leonard, inventor (to AF) and Douglas M. Allen, inventor (to AF) 16 Aug. 1988 5 p Filed 18 Aug. 1987
(AD-D014025; US-Patent-4,763,529; US-Patent-Appl-SN-087857) Avail: US Patent and Trademark Office CSCL 11/2

A method and apparatus for static fatigue testing of a ceramic material is described wherein a thin plate of a ceramic material is supported at opposite ends in a liquid sodium bath inside an enclosure containing a gaseous atmosphere inert to reaction with liquid sodium. The ceramic plate and sodium bath are controllably heated to a preselected temperature. Known loads are applied to the ceramic plate through a loading head having a pair of contact points on the ceramic plate at a position intermediate to its opposite ends within the sodium bath. Displacements of the loading head at corresponding loads are measured to generate output signals characteristic of loads on the ceramic plate. GRA

N89-26094# Pennsylvania State Univ., University Park. Center for Advanced Materials.
FUNDAMENTAL STUDIES OF CORROSION OF NONOXIDE STRUCTURAL CERAMICS. VOLUME 1: SINGLE CRYSTAL SILICON CARBIDE Final Report, 1 Jan. 1985 - 30 Jun. 1988
Z. Zheng, R. E. Tressler, and K. E. Spear Oct. 1988 419 p
(Contract GRI-5084-260-1083)
(PB89-167456; CAM-8812-Vol-1; GRI-89/0051-Vol-1) Avail: NTIS HC A18/MF A01 CSCL 11C

Oxidation of single crystal SiC in dry oxygen (0.001 to 1 atmospheres and 1200 to 1500 C) followed parabolic kinetic behavior. Two different apparent activation energies were calculated for oxidation of the (0001) carbon faces of SiC (around 120 KJ/ mole below 1350 C and 260 KJ/mole above 1350 C). Two regimes were not apparent for oxidation of the (0001) carbon face decreased with increasing temperature (from 0.6 at 1200 C to 0.2 at 1500 C). Double oxidation experiments using 1602 and 1802 indicated dominant oxidant transport by molecular oxygen at lower temperatures (less than 1300 C) and a substantial contribution diffusion of ionic oxygen at higher temperatures. Epitaxially grown Si 13C films on alpha-Si 12C substrates via CVD were used to study carbon transport behavior during oxidation of SiC. SIMS analyses showed that carbon can transport quickly through the oxide layer, which eliminates the possibility that transport of carbonaceous species is rate controlling in oxidation of SiC. A kinetic model was proposed based on parallel transport of oxidants through the oxide via molecular and ionic oxygen diffusion mechanisms, which best fits the observed oxidation behavior. Additions of 1.5% chlorine gas in oxidizing ambients enhanced the oxidation rate of SiC. Bubbles formed during SiC

oxidation in the presence of chlorine, causing oxide surface roughening. Author

N89-26095*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DETERMINATION OF THE THERMAL STABILITY OF PERFLUOROALKYLETHERS BY TENSIMETRY: INSTRUMENTATION AND PROCEDURE
Larry S. Helmick (Cedarville Coll., OH.) and William R. Jones, Jr. 1989 31 p Presented at the STLE-ASME Tribology Conference, Fort Lauderdale, FL, 16-19 Oct. 1989
(NASA-TM-102116; E-4891; NAS 1.15:102116) Avail: NTIS HC A03/MF A01 CSCL 11C

A computerized tensimeter and experimental procedure for determination of the thermal decomposition temperature (T sub d) of perfluoro alkylethers were developed and tested. Both the apparatus and the procedure are described in detail. Results of testing with bis(2-ethylhexyl) phthalate and trimethylolpropane triheptanoate demonstrate that the reciprocal of the decomposition temperature is a linear function of the logarithm of the gas volume/heated liquid volume ratio. The T sub d obtained for each compound at a gas volume/heated liquid volume ration of one was similar to the value previously reported using an isoteniscope technique. Results of testing with a polymer of hexafluoropropylene oxide demonstrate that this instrument and procedure can be used to determine the T sub d of perfluoroalkylethers. Author

N89-26096*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
ANTISTATIC SPRAYS
James E. Ming Jul. 1989 23 p
(NASA-TM-100740; Rept-89B00138; NAS 1.15:100740) Avail: NTIS HC A03/MF A01 CSCL 11C

Antistatic sprays from several different manufacturers are examined. The sprays are examined for contamination potential (i.e., outgassing and nonvolatile residue), corrosiveness on an aluminum mirror surface, and electrostatic effectiveness. In addition, the chemical composition of the antistatic sprays is determined by infrared spectrophotometry, mass spectrometry, and ultraviolet spectrophotometry. The results show that 12 of the 17 antistatic sprays examined have a low contamination potential. Of these sprays, 7 are also noncorrosive to an aluminum surface. And of these, only 2 demonstrate good electrostatic properties with respect to reducing voltage accumulation; these sprays did not show a fast voltage dissipation rate however. The results indicate that antistatic sprays can be used on a limited basis where contamination potential, corrosiveness, and electrostatic effectiveness is not critical. Each application is different and proper evaluation of the situation is necessary. Information on some of the properties of some antistatic sprays is presented in this document to aid in the evaluation process. Author

N89-26097# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
ORGANOSILICON COMPOUNDS AND POLYMERS AND SILICON CERAMICS Final Scientific Report, 1 Oct. 1985 - 31 Oct. 1988
Dietmar Seyferth 2 Mar. 1989 14 p
(Grant AF-AFOSR-0265-85; AF Proj. 2303)
(AD-A206589; AFOSR-89-0389TR) Avail: NTIS HC A02/MF A01 CSCL 07/3

The n-BuLi/Me3COK reagent metalates every fourth CH2 group of ((CH3)2SiCH2)n. The metalated polymer was converted to vinyl-containing polycarbosilanes whose reaction with ((CH3SiH)x (CH3Si)y)n gave useful preceramic polymers. Cross-linkable (CH3(H)SiCH2)n was prepared using (CH3(Ph)SiCH2)n as starting material. The reactions of ((CH3SiH)x(CH3Si)y)n with Cp2MMe2 (M = Ti, Sr, Hf) gave precursors for SiC/MC blends. 1,1,3,3-Tetramethyl 1,3-disilacyclobutane can be metalated with t-BuLi/TMEDA. GRA

N89-26098# Texas Univ., Arlington. Dept. of Chemistry.
SYNTHESIS AND CHARACTERIZATION OF A SERIES OF ALTERNATING COPOLYMERS (OLIGOMERS) CONTAINING ORGANOPHOSPHA-LAMBDA 5-AZENE BACKBONE MOIETIES
Martin Poerantz and Mark W. Victor 3 Apr. 1989 14 p Submitted for publication Sponsored by the Robert A. Welch Foundation
(Contract N00014-86-K-0769)
(AD-A206592; TR-15) Avail: NTIS HC A02/MF A01 CSCL 07/6

The Staudinger reaction of bis(diphenylphosphino) alkyl or aryl compounds with 1,4-diazidobenzene at room temperature in benzene solution was shown to produce poly (organophospha (lambda 5) azenes), which are alternating copolymers (oligomers) with the general formula (=P(Ph)2-R-P(Ph)2=N-C6H4-N=)n where R=(CH2)n, n=2-5, or R=p-C6H4. The CP/MAS C-13 and P-31 nuclear magnetic resonance (NMR) spectra were consistent with the proposed structures and showed a small amount of P=O end groups in addition to the P=N P-31 resonances. The diffuse reflectance fourier transform infrared (FT-IR) spectra showed the typical P=N absorptions characteristic of phospha (lambda 5) azenes along with some azido end group absorptions. The thermogravimetric analyses (TGA) of these polymers showed that they were reasonably thermally stable up to about 300 C, and differential scanning calorimetry (DSC) provided the glass transition temperatures,(Tg). The Tg's for the polymethylene containing polymers were in the range 103-124 C and appeared to decrease with increasing length of the polymethylene chain. Approximate molecular weights of these insoluble polymers were obtained by end group analysis using the integrated areas from the P-31 NMR spectra (ratio of P=O and P=N groups) and assuming that P=O and N3 were the end groups. GRA

N89-26099# Army Materials Technology Lab., Watertown, MA. Polymer Research Branch.
CHARACTERIZATION AND CURE MONITORING OF STRUCTURAL ADHESIVES Final Report
Walter X. Zukas, Howard H. Wong, David A. Dunn, and Stanley E. Wentworth Feb. 1989 24 p
(DA Proj. 1L1-61102-AH-42H)
(AD-A206611; MTL-TR-89-15) Avail: NTIS HC A02/MF A01 CSCL 11/1

Two potential replacement adhesives for a discontinued commercial adhesive were investigated. The composition and curing behavior of the replacements were compared to the commercial system utilizing a number of analytical techniques. High performance liquid chromatography, size exclusion chromatography, and thermogravimetric analysis were applied to establish the lot-to-lot consistency of the adhesive component composition. The thermal, dynamic mechanical, rheological, and dielectric properties, as a function of cure, were monitored by differential scanning calorimetry, torsional braid analysis, parallel plate rheometry, and microdielectrometry, respectively. Correlations between the various techniques and the state of cure of the adhesive were made. The glass transition temperature of the adhesive was observed to be a very sensitive measure of the state of cure. GRA

N89-26100# Arizona State Univ., Tempe. Dept. of Chemistry.
NEW ALIPHATIC POLYMALONAMIDES
M. Tomida and H. K. Hall, Jr. 1 Apr. 1989 10 p
(Contract N00014-87-K-0438)
(AD-A206758; TR-1) Avail: NTIS HC A02/MF A01 CSCL 07/6

New aliphatic polymalonamides were synthesized by interfacial polymerization and bulk polymerization using phenyl esters. Polymers obtained by bulk polymerization revealed higher inherent viscosities than those obtained by interfacial polymerization. Films of several polymers were made by melt procedures. By DSC, only 7-3 polymalonamide was crystalline. GRA

N89-26101# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
RUTILE TITANIUM DIOXIDE AND ITS USE IN POLYMER SYSTEMS Phase Report, Oct. - Dec. 1988
Charles R. Hegedus 5 Jan. 1989 19 p
(AD-A206787; NADC-89008-60) Avail: NTIS HC A03/MF A01 CSCL 07/2

The following is a phase report which presents a literature review on the use of rutile titanium dioxide in polymer systems. It is part of an overall project to study the thermodynamics of polymer-pigment interactions and the relationship between these interactions and the bulk properties of organic coatings. Titanium dioxide is extensively used as a filter in polymer systems because of its ability to impart whiteness, opacity, and chemical stability to the resulting composite. The manufacturing process and properties of rutile titanium dioxide are reviewed. The properties of composites produced from titanium dioxide and polymer systems are also reviewed. These properties are discussed in relation to polymer-particle interactions. An approach is presented to study polymer-pigment interactions by analyzing thermodynamic properties such as enthalpy, entropy, and free energy of adsorption. GRA

N89-26102# Defence Research Establishment Atlantic, Dartmouth (Nova Scotia). Technical Div.
A PRELIMINARY STUDY OF SOME METHODS FOR FOLLOWING THE ACCELERATED AGING AND LIFE PREDICTION OF RUBBERS
J. A. Hiltz and S. C. Hattie Mar. 1989 46 p
(AD-A206791; DREA-TM-89/205) Avail: NTIS HC A03/MF A01 CSCL 11/10

Forty three rubber samples aged at temperatures between 70 C and 150 C for periods up to three hundred days were investigated using hardness tests, dynamic mechanical analysis and pyrolysis-gas chromatography-mass spectrometry to determine if these techniques might be useful in monitoring the aging of the samples. The samples were formulated and aged. They included twenty-seven acrylonitrile-butadiene rubber samples, twelve polychloroprene rubber samples, and four polyisoprene rubber samples. All three techniques were capable of monitoring changes in the rubbers which correlated with the time and temperature of exposure of the samples. However, successful application of these techniques to the quantitative prediction of lifetime of elastomers from accelerated tests will require further experimentation. GRA

N89-26103# Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
CRACK-GROWTH RESISTANCE IN TRANSFORMATION-TOUGHENED CERAMICS
David M. Stump and Bernard Budiansky Jun. 1989 22 p
(Contract N00014-86-K-0753)
(AD-A206849; MECH-124) Avail: NTIS HC A03/MF A01 CSCL 11/2

Crack-growth resistance in transformation-toughened ceramics is studied by modeling the region surrounding an advancing crack tip as a zone which has undergone a uniform dilatational phase transformation. This zone is allowed to evolve around advancing crack tip under conditions of increasing far-field load while the tip is maintained at a critical stress intensity necessary for fracture. This procedure leads to the surprising conclusion that maximum toughening occurs for finite amounts of crack advance. The discovery of enhanced fracture toughness zirconia-enriched ceramics has led to a flurry of experimental and theoretical analyses. It has been well established that the high stresses near a crack tip can cause small zirconia particles, typically one micron or less in diameter, to undergo a phase transformation from a tetragonal to a monoclinic crystal structure. GRA

N89-26104# Rome Air Development Center, Griffiss AFB, NY.
HIGH QUALITY ADHESIVE ANALYSIS Report, Oct. 1983 - Jul. 1986
Luke A. Lorang Feb. 1989 14 p
(AD-A206920; RADC-TR-89-23) Avail: NTIS HC A03/MF A01 CSCL 11/10

The purpose of this in-house project was to characterize organic adhesives used or being considered for use in microelectronic packages and assess their impact on reliability. Based on the results of adhesive characterization, a specification would be generated defining the critical properties required of these adhesives. A minimal amount of in-house adhesive evaluation was conducted due to problems in acquiring adhesives and procuring an ultra-low temperature freezer for storage of these shelf-life limited materials. With much industry input and support, the adhesive document was released as a MIL-STD-883 test method and not as a separate specification as earlier anticipated. Funding for the project was cancelled and the project was terminated. GRA

N89-26105# North Carolina Univ., Chapel Hill. Dept. of Chemistry.
AN IN-SITU ELLIPSOMETRIC STUDY OF AQUEOUS NH(4)OH TREATMENT OF SILICON Interim Report
G. Gould and E. A. Irene 14 Mar. 1989 29 p Submitted for publication
(Contract N00014-89-J-1178)
(AD-A206940; TR-24) Avail: NTIS HC A03/MF A01 CSCL 07/2

In-situ ellipsometry at a wavelength of 632.8nm is used to analyze silicon surfaces in an aqueous NH4OH ambient. The ellipsometric data indicate that a surface which is optically quite similar to bare Si is obtained when the native SiO2 film is etched from a Si substrate by aqueous NH4OH. In contrast, the surface obtained by etching the native oxide in aqueous buffered HF4 leads to formation of a residual film on the Si substrate. Roughening of sample surfaces treated with either aqueous NH4OH or BHF is observed by microscopy. The high degree of roughness obtained following NH4OH treatment appears to influence ellipsometric measurements on samples, but this influence is not observed following BHF exposure where less roughness is noted. GRA

N89-26106# Rockwell International Corp., Thousand Oaks, CA. Science Center.
ENVIRONMENTAL INTEGRITY OF COATING/METAL INTERFACE Annual Progress Report, 1 Feb. 1988 - 31 Jan. 1989
M. Kendig, P. Stocker, and J. Lumsden Mar. 1989 36 p
(Contract N00014-87-C-0075)
(AD-A207123; SC5508.APR) Avail: NTIS HC A03/MF A01 CSCL 11/3

It is the objective of this project to establish the molecular details of the corrosion-induced loss of adhesion of organic films from steel. Scanning Acoustic Microscopy (SAM) has allowed observation of the microscopic details of the attack of cathodic corrosion products on a model organic coating on steel. Attack of the polymer by the alkaline corrosion products occurs at numerous localized regions resulting in the mechanical degradation of the coating/metal interface. Acoustic microscopy has also provided a rapid determination of the kinetics of the disbonding process. The disbond distance away from a cathodically polarized scribe increases with the square root of time. The corresponding rate parameter Kd increases with increasing potential for applied potentials below minus 750 mV vs Ag/AgCl. GRA

N89-26107# Rome Univ. (Italy). Dipartimento di Fisica.
DIRECTED POLYMERS WITH COMPLEX AMPLITUDES
Yi-Cheng Zhang 27 Oct. 1988 13 p Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-637; ETN-89-94717) Avail: NTIS HC A03/MF A01

The generalized directed polymer model in which the amplitudes along a polymer assume random complex values is studied. It is shown that complex disorder can cause stronger transverse fluctuations than real positive disorder previously studied. A replica method is used to map the model onto a system of n pairs of

opposite charged bosons. Quantitative analytical arguments are given to show that complex disorder results in larger transverse fluctuations. ESA

N89-26108# Technische Univ., Delft (Netherlands).
A STUDY ON ORIENTATION-INDUCED CRYSTALLIZATION IN TWO-PHASE POLYMER MELT SYSTEMS Ph.D. Thesis
Constantinus Leonard Verbraak 1988 97 p
(ETN-89-94892) Avail: NTIS HC A05/MF A01

Self-reinforcement of polymer blends by orientation-induced crystallization was studied. An analysis of the process of orientation-induced crystallization in a polymer melt is given in terms of a balance between deformation, relaxation, and crystallization time scales. Deformation phenomena in two-phase polymer systems and the relaxation behavior of a stretched polymer melt were examined. Cocontinuous, concentric two-phase polymer flow through a cylindrical channel is analyzed with different models, and theoretical predictions are compared with experimental data. Results based on the power law model give the best description of the experimental observations. General conditions for fiber formation from a dispersion as presented in literature are compared with experimental data. They appear not to be generally valid and can be influenced by process geometry. The relaxation behavior of a stretched polymer melt can be predicted to a fair extent with the aid of Wagner's constitutive equation. ESA

28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

N89-26109# National Aerospace Lab., Tokyo (Japan).
METAL COMBUSTION IN SOLID-PROPELLANTS
Muneo Izumikawa, Mamoru Takahashi, Tohru Mitani, Takashi Niioka, Masatoshi Chiba, and Kazushige Kato Sep. 1988 35 p In JAPANESE; ENGLISH summary
(NAL-TR-998; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

A technique using a strand burner was developed to investigate the combustion efficiency of metals in solid propellants. A strand of propellants was burned under a given pressure and all reactants and products were trapped in the closed vessel. Condensed and gaseous species were analyzed quantitatively using various titration methods and gas-chromatography. The results derived from the strand burner were compared with the eta(c)* evaluated from firing tests of subscale motors. The combustion efficiency of A1 and B in various propellants was measured. A combustion model for metal powders including agglomeration, ignition and steady burning of particles was investigated. Effects of B/A1 ratios and particle size of B on the combustion efficiency of propellants containing A1 and B were discussed based on the combustion model. Author

N89-26110# IIT Research Inst., Bartlesville, OK. National Inst. for Petroleum and Energy Research.
COMPARISONS BETWEEN UNLEADED AUTOMOBILE GASOLINE AND AVIATION GASOLINE ON VALVE SEAT RECESSION IN LIGHT AIRCRAFT ENGINES Final Report
Jerry R. Allsup May 1989 19 p
(Contract DTFA03-88-A-00016)
(NIPER-409; DOT/FAA/CT-TN89/33) Avail: NTIS HC A03/MF A01

Testing was conducted to determine the potential for excessive valve seat recession in light aircraft engines using unleaded automobile gasoline (autogas) fuel. Two I0320 Lycoming engines were operated on a test stand for a 150 hr duration; one engine used 100LL aviation gasoline (avgas) and the other used unleaded premium autogas. New original equipment manufacture (OEM) valve seats (hardness Rockwell HRB 40) were installed at the beginning of the test and recession was measured at 16 hr intervals. The air-fuel mixture was precisely controlled by monitoring exhaust gas composition. Results show valve seat recession using unleaded autogas fuel was not significantly different from 100LL avgas. Author

N89-26111# Air Force Astronautics Lab., Edwards AFB, CA.
OH LIF (LASER-INDUCED FLUORESCENCE) TEMPERATURE MEASUREMENTS IN HIGH PRESSURE SOLID PROPELLANT FLAMES Interim Report, Jan. 1988 - Jan. 1989
J. Tim Edwards Mar. 1989 62 p
(AF Proj. 2308)
(AD-A206637; AFAL-TR-89-003) Avail: NTIS HC A04/MF A01 CSCL 21/9

An attempt to apply hydroxyl radical laser induced fluorescence temperature measurements to high pressure solid propellant flames is described. The requirement for broadband spectral collection is discussed. In high pressure propellant flames of AP, HMX, and AN, the broadband detection decreased the light rejection of the system to the point that scattered laser light overwhelmed the OH LIF signal and rendered the measurement unsuccessful. Earlier CN and OH LIF experiments using narrowband data collection were successful, allowing radical profiles to be obtained. The difference between the two sets of experiments illustrate the need for high light rejection efficiencies in any laser-diagnostic measurement in the highly scattering environment of a propellant flame. GRA

N89-26112# Department of the Navy, Washington, DC.
SELF CONSUMABLE INITIATOR Patent Application
Robert E. Betts, inventor (to Army) 3 Jan. 1989 10 p Filed 3 Jan. 1989
(AD-D014088; US-Patent-Appl-SN-293157) Avail: NTIS HC A02/MF A01 CSCL 21/9

A self consumable initiator is comprised of a consumable material selected from pyrotechnics, propellants, exothermic alloys, and primary explosive compositions, and one or more lengths of a fiber optic material in physical contact with or embedded in the consumable material. Uniform density of laser energy is transmitted through the fiber optic material to the consumable material in sufficient amount to stimulate the consumable material to its respective ignition point. The consumable material self consumes as it serves to ignite a larger quantity of material such as solid propellant grain. The consumable material is in the form of pellets, powders, or castable shapes. When installed in a rocket motor case, the self consumable initiator is bonded or installed as a castable pyrotechnic which conforms to the contour of the front end of a solid rocket motor case. Subsequently, a solid propellant grain is bonded or cast in place in intimate contact with the initiator. After being stimulated to its ignition point with laser energy the consumable material serves to ignite the solid propellant grain. The consumable material is in the form of pellets, powders, or castable shapes. When installed in a rocket motor the self consumable initiator is bonded or installed as a castable pyrotechnic which conforms to the contour of the front end of a solid rocket motor case. Subsequently, a solid propellant grain is bonded or cast in place in intimate contact with the initiator. GRA

29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

N89-26113# National Aerospace Lab., Tokyo (Japan). Space Technology Research Group.
IMPROVED DROP TOWER PERFORMANCE FOR MICROGRAVITY ENVIRONMENT EXPERIMENTS
Sachio Ogiwara, Shohichi Yoshiwara, and Hisao Azuma Aug. 1988 19 p In JAPANESE; ENGLISH summary
(NAL-TR-991; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

The non-gravity environment of space provides such attractive

features as zero convection and zero buoyancy due to density gradient. In a microgravity environment several interesting phenomena such as Marangoni flow motion, wet skin on the surface, etc., take place but can not be observed on the earth with the gravity acceleration effect. To create such a microgravity environment, various techniques have been attempted using a drop tower, and flights on space shuttle, rocket, aircraft, and from balloon, each of which has been successfully applied for the purpose of the respective experimental surveys. Among these types, the drop tower test rig has the capability of easily repeating the required experiments at an appropriate low gravity level, though the duration of microgravity is not long. Described here is an improved drop tower method to better yield a low gravity environment and an effective damping of landing shock for more accurate measurements during very short drop testing on the order of one second. Author

N89-26114*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

FEASIBILITY OF REDUCED GRAVITY EXPERIMENTS INVOLVING QUIESCENT, UNIFORM PARTICLE CLOUD COMBUSTION

Howard D. Ross, Lily T. Facca, Abraham L. Berlad, and Venkat Tangirala (California Univ., San Diego.) Mar. 1989 40 p
(NASA-TM-101371; E-4417; NAS 1.15:101371) Avail: NTIS HC A03/MF A01 CSCL 22A

The study of combustible particle clouds is of fundamental scientific interest as well as a practical concern. The principal scientific interests are the characteristic combustion properties, especially flame structure, propagation rates, stability limits, and the effects of stoichiometry, particle type, transport phenomena, and nonadiabatic processes on these properties. The feasibility tests for the particle cloud combustion experiment (PCCE) were performed in reduced gravity in the following stages: (1) fuel particles were mixed into cloud form inside a flammability tube; (2) when the concentration of particles in the cloud was sufficiently uniform, the particle motion was allowed to decay toward quiescence; (3) an igniter was energized which both opened one end of the tube and ignited the suspended particle cloud; and (4) the flame proceeded down the tube length, with its position and characteristic features being photographed by high-speed cameras. Gravitational settling and buoyancy effects were minimized because of the reduced gravity enviroment in the NASA Lewis drop towers and aircraft. Feasibility was shown as quasi-steady flame propagation which was observed for fuel-rich mixtures. Of greatest scientific interest is the finding that for near-stoichiometric mixtures, a new mode of flame propagation was observed, now called a chattering flame. These flames did not propagate steadily through the tube. Chattering modes of flame propagation are not expected to display extinction limits that are the same as those for acoustically undisturbed, uniform, quiescent clouds. A low concentration of fuel particles, uniformly distributed in a volume, may not be flammable but may be made flammable, as was observed, through induced segregation processes. A theory was developed which showed that chattering flame propagation was controlled by radiation from combustion products which heated the successive discrete laminae sufficiently to cause autoignition. Author

N89-26115# Manchester Univ. (England). Dept. of Engineering.

THE 1986 HOULDSWORTH MEMORIAL LECTURE: TAKING THE HIGH GROUND (THE COMMERCIAL EXPLOITATION OF SPACE)

Oct. 1987 20 p Lecture held in Manchester, United Kingdom, 1986
(AERO-Rept-8706; ETN-89-94946) Avail: NTIS HC A03/MF A01

The history of space exploitation is reviewed and possibilities for commercialization of the space environment are discussed. ESA

31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

N89-26116 British Broadcasting Corp., London (England). Dept. of Research.

SOME PROPERTIES OF ANTIVIBRATION MOUNTS USED IN BUILDING ISOLATION

C. D. Mathers and R. Walker 1989 13 p
(BBC-RD-1989/3) Avail: BBC, Kingswood Warren, Tadworth, Surrey, England

Comparative assessments were made of several different types of large antivibration mountings by using them to isolate a compact steel mass whose behavior closely approximates ideal (non-modal) behavior over the frequency range 0 to about 450 Hz. The mounts whose behavior deviated most from that of an ideal compliance were helical steel springs without inter-coil damping. Further laboratory investigations on much smaller springs showed that their modal behavior was not very dependent on loading, and that the performance of large mounts under a small fraction of their working load provided a resonable indication of their probable performance in normal use. The experiments also showed that the placing of a ribbed rubber mat or noise-stop pad under such a spring provided effective damping of only some modes, and that if ideal performance were to be approached, than some more effective form of coil damping would be required. The effects of friction were also demonstrated, indicating that special care was needed in the design and construction of isolation systems for use at low vibration levels. A simple mathematical model was set up which used a finite-element representation of the spring's distributed compliance and mass, but in which no account was taken of its detailed physical behavior. This model was sufficient to reproduce the general form of the measured isolation curves, and therefore to confirm that the behavior of the experimental setup was indeed due to spring modes. K.C.D.

N89-26117 British Broadcasting Corp., London (England). Dept. of Research.

THE CONTROL OF THE AUDIBLE EFFECTS OF GROUND VIBRATIONS IN BUILDING STRUCTURES

R. Walker and C. D. Mathers 1989 43 p
(BBC-RD-1989/2) Avail: BBC, Kingswood Warren, Tadworth, Surrey, England

Over a period of about eight years a large amount of investigation into the problems of vibration isolation, particularly of large structures, has been carried out, mostly in preparation for the development of a site (the Langham) which is subject to severe vibration interference from London Underground trains. An extensive series of tests and measurements was carried out on a purpose-built, experimental test slab in the basement of the existing building on the Langham site. Other comparative measurements were made. The well-known limitations of some types of commercial vibration isolation mountings as a result of modal vibration responses have been demonstrated and, for the isolation of large structures, additional limitations due to the modal vibrations of the supported structures have been quantified. Additionally, and most importantly, the severely limiting effects of acoustic coupling have been measured to be much larger than had been suspected. The achievable isolation of a studio-like structure was limited to a maximum of about 25 dB at all frequencies, for a single-stage system. Some simple theoretical analyses of the actual, imperfect behavior mechanisms of vibration isolation systems, when taken together with other measurements, have enabled predictions of the performance of proposed isolation systems to be made with reasonable accuracy. It is shown that an expensive double isolation system is likely to be required to satisfy the normal criterion for the drama studio background noise level on the Langham site. Subsequently, the development of the Langham site was abandoned but the results of the work are applicable to any studio site which is subject to ground-borne vibrations. Author

N89-26118# Technische Univ., Eindhoven (Netherlands).

SINGLE-POINT DIAMOND TURNING Ph.D. Thesis
Tjoe Chong George Lo-A-Foe 1989 196 p
(ETN-89-94881) Avail: NTIS HC A09/MF A01

A cutting model for describing the influence of operational settings, material properties of the work-piece, and tool geometry upon cutting forces was evaluated. Experiments show that features ignored in the starting model, such as the influence of the forces on the clearance face and of the strain rate upon material properties, may not be neglected in single-point diamond turning. If these effects are taken into account, the cutting forces can be predicted within 20 percent. The dynamic behavior of a precision machine was determined by modal analysis. A method which uses experimental data was applied to determine how the weak elements should be modified in order to improve the performance of the machine data. A numerical model, which includes the results from previous analyses, was developed to simulate the direct influence of the operational settings, the material properties of the work-piece, the geometry of the cutting tool, and the dynamic behavior and their indirect influence, via the cutting forces, upon the surface roughness. Model accuracy is beter than 10 percent.
ESA

N89-26119# Technische Univ., Delft (Netherlands).
AN AUTOMATED SYSTEM FOR EXPERIMENTS AT LOW AND VERY LOW TEMPERATURES. APPLICATION TO DYNAMIC SPECIFIC HEAT MEASUREMENTS Ph.D. Thesis
Wim Adrian Bosch 1988 124 p
(ETN-89-94887) Avail: NTIS HC A06/MF A01

The construction and performance of an automated, computer controlled cryogenic system for experiments at temperatures between a few millikelvins and 4K are described. The system consists of three main parts (1), (2) and (3). Part (1) is an He3-circulating dilution refrigerator system, capable of cooling fairly large and complicated experiments in a magnetically shielded region of 2dmcu down to 15mK in a continuous mode and down to 4mK after adiabatic demagnetization of a hyperfine enhanced nuclear magnet. Part (2) is a Faraday cage containing the sensitive electronic measuring equipment connected to experiments inside the refrigerator. Part (3) consists of two microcomputers, a minicomputer, and other equipment for automatic control of the experiments, for data acquisition, storage and conversion, and for displaying results. Low temperature thermometry is summarized.
ESA

32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

N89-26120# Electroimpact, Inc., Seattle, WA.
ELECTROMAGNETIC EMISSIONS FROM A MODULAR LOW VOLTAGE ELECTRO-IMPULSE DE-ICING SYSTEM Final Report
Peter Zieve, Brent Huffer, and James Ng Mar. 1989 44 p
(DOT/FAA/CT-88/31) Avail: NTIS HC A03/MF A01

An important consideration in the certification of electro-impulse deicing (EIDI) systems for aircraft ice protection is electromagnetic interference (EMI). When the capacitor bank in an EIDI system discharges, a large pulse of current travels down a transmission line to the coil. Subsequent radiation by the transmission line and the coil produces EMI. The low voltage electro-impulse deicing system (LVEIDI) is unique in that the capacitor bank is mounted adjacent to the coil thereby eliminating most of the cables. Electromagnetic emissions from this system would then be primarily from the coil. The performed tests investigate the EMI environment inside and outside of both a composite and an aluminum wing. Due to the absence of the shielding effect of aluminum, the problem of electromagnetic emissions is particularly severe when the wing is constructed of composite materials. Measurements of the radiated electric field indicate that emissions from the aluminum wing were well within the standards. Some tests with the composite wing were within standards while others were not. It was found that the composite wing could be brought back into compliance through the addition of thin metallic shielding. Conducted emissions on the LVEIDI power feed cable were brought within standards with the addition of a line filter. An unshielded connection cable for a compass flux valve was run through the wing just behind the LVEIDI module. Discharge of the capacitor bank had no discernible effect on operation of the compass flux valve. No problems were observed in other tests of the wing internal environment.
Author

N89-26121# Federal Aviation Administration, Atlantic City, NJ.
FUNCTIONAL REQUIREMENTS OF THE COMMUNICATIONS INTERFACE DRIVER (CID)
Jeffrey Livings, James Davis, Charles Dudas, and Mark Schoenthal Jun. 1989 23 p
(Contract T-1007-A)
(DOT/FAA/CT-TN87/41-Rev) Avail: NTIS HC A03/MF A01

The functional requirements that the Communications Interface Driver (CID) was built to and tested against are listed. The CID is a test tool whose purpose is to supply and receive a capacity level of communications messages to and from the air traffic control (ATC) ports of the Mode S sensor. A requirements document was necessary since there were no specifications given for the CID in the Mode S specifications. Note that this document lists the functional requirements for the CID and is not a detailed specification.
Author

N89-26122*# Applied Research Corp., Huntsville, AL.
ANTENNA PATTERN STUDY, TASK 2 Final Report
Warren Harper 29 Mar. 1989 55 p
(Contracts NAS8-37194; UI/ARI-88-1)
(NASA-CR-183651; NAS 1.26:183651; ARI/R-89-576Z-Task-2)
Avail: NTIS HC A04/MF A01 CSCL 20N

Two electromagnetic scattering codes, NEC-BSC and ESP3, were delivered and installed on a NASA VAX computer for use by Marshall Space Flight Center antenna design personnel. The existing codes and certain supplementary software were updated, the codes installed on a computer that will be delivered to the customer, to provide capability for graphic display of the data to be computed by the use of the codes and to assist the customer in the solution of specific problems that demonstrate the use of the codes. With the exception of one code revision, all of these tasks were performed.
Author

N89-26123# Federal Aviation Administration, Atlantic City, NJ. Technical Center.
COMMUNICATIONS INTERFACE DRIVER (CID) SYSTEM USER'S MANUAL
Tom Bratton, Charles Dudas, Mark Schoenthal, Jim Davis, Andrew Leone, and Jeffrey Livings Jun. 1989 71 p
(DOT/FAA/CT-TN89/36) Avail: NTIS HC A04/MF A01

This user's manual for the Communications Interface Driver (CID) systems is used to describe the operating procedures of the CID. The CID system is a test tool intended to supply or receive a capacity level of communications messages to and from the air traffic control (ATC) and non-ATC ports of the Mode Select (Mode S) sensor. The primary intent of the CID user's manual is to guide the user through the operating procedures of the X.25 communications diagnostic (COMMDIAG) and Time-of-Year (TOY) diagnostic programs, the scenario generator and CID initialization (CIDINIT) data base off-line support programs, the CID real-time program and the scenario list (SCLIST) and extraction list (EXLIST) data analysis programs. The manual also includes the procedures to boot the CID system and to handle the required cabling and baud rate switch setup.
Author

N89-26124# Atlantic Aerospace Electronics Corp., Waltham, MA.
HARDWARE-SPECIFIC SYMBOLIC SIGNAL MANIPULATION Final Report, 15 Aug. 1988 - 14 Feb. 1989
Cory Myers 13 Mar. 1989 49 p
(Contract DAAL03-88-C-0018)
(AD-A205630; ARO-25960.1-EL-SBI) Avail: NTIS HC A03/MF A01 CSCL 12/5

The goal was to demonstrate extensions to current systems for signal representation and manipulation. The long term goal is to develop CAD assistants for the design, development, and test of signal processing algorithms. In Phase 1 we did the following: Surveyed several current Digital Signal Processing (DSP) processors and developed an understanding of the common features of these processors. Developed an explicit representation for an abstract processor that can be specialized to model specific DSP processors. GRA

N89-26125 Department of the Air Force, Washington, DC.
SUSPENDED ANTENNA WITH DUAL CORONA RING APPARATUS Patent
Glenn R. Beach, inventor (to AF), Marcus Slobins, inventor (to AF), and Myron S. Wheeler, inventor (to AF) 13 Sep. 1988 6 p Filed 4 Dec. 1986
(AD-D014024; US-Patent-4,771,292; US-Patent-Appl-SN-937957; US-Patent-Class-343-707) Avail: US Patent and Trademark Office CSCL 09/7

The aerostat-supported antenna/tether cable of a communication system is protected from destructive corona discharges by a dual corona ring assembly which attaches the feed cable of the transmitter to the antenna. The voltage divider assembly includes upper and lower corona rings which have a space between them which is an isolated and corona-free attachment point for the feed cable. By attaching the voltage divider assembly to the antenna/tether cable at about 12 to 15 feet above the ground, the base of the antenna/tether cable distributes the feed voltage along its length to levels below those voltage levels in which destructive ionization may occur. GRA

N89-26126*# Ohio State Univ., Columbus. Dept. of Electrical Engineering.
ADAPTIVE ARRAY FOR WEAK INTERFERING SIGNALS: GEOSTATIONARY SATELLITE EXPERIMENTS M.S. Thesis
Karl Steadman 1989 148 p
(Grant NAG3-536)
(NASA-CR-185450; NAS 1.26:185450) Avail: NTIS HC A07/MF A01 CSCL 20N

The performance of an experimental adaptive array is evaluated using signals from an existing geostationary satellite interference environment. To do this, an earth station antenna was built to receive signals from various geostationary satellites. In these experiments the received signals have a frequency of approximately 4 GHz (C-band) and have a bandwidth of over 35 MHz. These signals are downconverted to a 69 MHz intermediate frequency in the experimental system. Using the downconverted signals, the performance of the experimental system for various signal scenarios is evaluated. In this situation, due to the inherent thermal noise, qualitative instead of quantitative test results are presented. It is shown that the experimental system can null up to two interfering signals well below the noise level. However, to avoid the cancellation of the desired signal, the use a steering vector is needed. Various methods to obtain an estimate of the steering vector are proposed. K.C.D.

N89-26127# Federal Aviation Administration, Atlantic City, NJ. Technical Center.
MODE S PERFORMANCE TEST PLAN
Charles Baxter Jul. 1989 67 p
(DOT/FAA/CT-TN89/24) Avail: NTIS HC A04/MF A01

The Mode S Performance Tests to be conducted by t he Federal Aviation Administration Technical Center is described. The Mode S Performance Tests will provide a performance baseline and site-adaptation optimization effort for each Mode S configuration (terminal, en route, and multi-sensor). System level accuracy and resolution tests will be conducted using live test aircraft and precision trackers. These tests have not been previously accomplished due to the lack of multiple sensors and precision trackers at the contractor's facility. A stress test effort will also be conducted to characterize the performance of the Mode S sensor beyond its specified requirements. This plan addresses the National Airspace System requirements and test objective as outlined in the Mode S Master Test Plan. This plan also identifies the organizational responsibilities, resources, coordination efforts, and success criteria necessary to develop a set of test procedures to accomplish the above tests. Author

N89-26128# Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.
THE PERFORMANCE OF CONVENTIONAL AND DBD (DIRECT BIT DETECTION) RECEIVERS FOR MFSK/QPSK MODULATION WHEN OPERATING IN THE PRESENCE OF NOISE AND RAYLEIGH FADING M.S. Thesis
Larry J. Rudy Dec. 1988 105 p
(AD-A206609) Avail: NTIS HC A06/MF A01 CSCL 12/9

The properties of a digital M-ary signaling scheme called MFSK/QPSK which combines the features of M-ary frequency shift keying (FSK) and quadriphase shift keying (QPSK) modulation are studied. This scheme is shown to be a form of biorthogonal signaling, and a receiver that is optimum in error rate sense is introduced and analyzed in order to obtain its bit error rate (BER) performance when signal interference can be modeled as additive white Gaussian noise. The bandwidth of the MFSK/QPSK signaling scheme is derived and compared with that of M-ary PSK and M-ary FSK signaling. MFSK/QPSK signaling results in receivers that provide error rates much lower than corresponding receivers for M-ary PSK and slightly lower than those for M-ary FSK, while maintaining a bandwidth efficiency at least three times greater than that of M-ary FSK though not as great as that of M-ary PSK signaling. A significant effort has been devoted to examining a detection method known as direct bit detection (DBD) which has been applied to M-ary PSK and MFSK/QPSK signaling, DBD receivers are introduced, and the BER of the MFSK/QPSK DBD receiver is derived and compared with that of the optimum (symbol discrimination) receiver. Lastly, the effects on performance due to Rayleigh fading are analyzed and evaluated for M-ary PSK DBD receivers as well as for MFSK/QPSK optimum (symbol discrimination) and DBD receiver. GRA

N89-26129# Minnesota Univ., Minneapolis. Inst. for Mathematics and its Applications.
SIGNAL PROCESSING Final Report, 1 Jul. - 13 Dec. 1988
Willard Miller, Jr. 28 Feb. 1989 39 p
(Grant AF-AFOSR-0283-88; AF Proj. 2304)
(AD-A206662; AFOSR-89-0412TR) Avail: NTIS HC A03/MF A01 CSCL 09/1

An integrated approach to 1-D and multidimensional problems in signal processing is presented. A broad range of problems and methods are examined. An effort was made to promote new interaction also within 1-D research groups (such as linear control and nonlinear control people) and within the multidimensional groups (such as radar, sonar and medical imaging. Some areas of study are: On the complexity of pattern recognition algorithms on a tree-structured parallel computer; Soliton mathematics in signal processing; The phase problem of X-ray crystallography; Extension problems under the displacement structure regime; Basic Algorithms in Tomography; Speech recognition using pattern recognition methods. GRA

N89-26130# Rome Air Development Center, Griffiss AFB, NY.
PROCEEDINGS OF THE ANTENNA APPLICATIONS SYMPOSIUM, VOLUME 1
Peter R. Franchi Jul. 1988 234 p Proceedings held at Hanscom AFB, MA, 23-25 Sep. 1987
(AD-A206704; RADC-TR-88-160-Vol-1) Avail: NTIS HC A11/MF A01 CSCL 25/2

The proceedings of the 1987 Antenna Applications Symposium

is a collection of state-of-the-art papers relating to phased array antennas, multibeam antennas, satellite antennas, microstrip antennas, reflector antennas, HF, VHF, UHF, and various other antennas. This is volume 1 of 2. GRA

N89-26131# Rome Air Development Center, Griffiss AFB, NY.
PROCEEDINGS OF THE ANTENNA APPLICATIONS SYMPOSIUM, VOLUME 2
Peter R. Franchi Jul. 1988 192 p Proceedings held at Hanscom AFB, MA, 23-25 Sep. 1987
(AD-A206705; RADC-TR-88-160-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 25/2

The proceedings of the 1987 Antenna Applications Symposium is a collection of state-of-the-art papers relating to phased array antennas, multibeam antennas, satellite antennas, microstrip antennas, reflector antennas, HF, VHF, UHF and various other antennas. This is volume 2 of 2. GRA

N89-26132# Naval Postgraduate School, Monterey, CA.
RADIATION SIGNATURES FROM A EXTERNAL RELATIVISTIC ELECTRON BEAM M.S. Thesis
Kyoum B. Wee Dec. 1988 68 p
(AD-A206706) Avail: NTIS HC A04/MF A01 CSCL 20/8

X-band radiation has been observed which occurs when an electron beam travelling in air traverses an aluminum plate. The radiation pattern is more complicated than can be explained with a simplified model of Cerenkov radiation from air and transition radiation from the aluminum-air interface. The empirical observation is that the peak angle decreases with energy until about 70 MeV, then increases with energy. The angular width of the peak distribution shows a similar behavior with energy. The observed peak angle decreases as the distance from the horn antenna to the aluminum foil is increased. The explanation of the radiation distribution observed is not yet satisfactory. A major improvement in the data accumulation process has been introduced by measuring radiation at a fixed angle as data is taken with a movable horn. This procedure allows us to compensate for the fluctuating electron beam intensity. The data can now be digitized and stored in a computer for analysis. Previous experiments allowed only for analog measurements. Further work, both theoretical and experimental, will be required to understand fully the radiation signature of the electron beam. GRA

N89-26133# Federal Aviation Administration, Atlantic City, NJ.
SATELLITE LOW RATE VOICE DEMONSTRATION TEST PLAN Test Plan Jan. 1988 - Mar. 1989
Joan Grelis Dec. 1988 18 p
(AD-A206710; DOT/FAA/CT-TN88/39) Avail: NTIS HC A03/MF A01 CSCL 25/4

This test plan describes the design of the demonstration of a low data rate voice Codec communications link via satellite. The demonstration will include the use of 4.8 kbps voice Codec equipment interfaced with a mobile satellite (MSAT) communications terminal installed in the Federal Aviation Administration's (FAA's) B- 727 (N-40) aircraft and similar equipment at the COMSAT ground earth station in Southbury, Connecticut. This configuration, used in conjunction with INMARSAT satellite capability, completes an aircraft-to-satellite-to-ground facility circuit that provides a communications quality voice link between the pilot and the ground. In addition to a demonstration, techniques will be developed for evaluating voice Codecs for air traffic control (ATC) applications. Controllers from the FAA will be used in the evaluation. A Codec Test Bed Facility will be developed to conduct stress testing in a laboratory controlled environment. This project will allow critical evaluation of digital voice satellite communications technology in a simulated ATC environment. GRA

N89-26134# Kansas Univ. Center for Research, Inc., Lawrence. Remote Sensing Lab.
FD-TD (FINITE-DIFFERENCE TIME-DOMAIN) SCATTERING FROM APERTURES Final Report, Mar. 1987 - Mar. 1988
Kenneth R. Demarest Oct. 1988 31 p
(Contract F30602-81-C-0205)
(AD-A206823; RSL-TR-5496-1; RADC-TR-88-217) Avail: NTIS HC A03/MF A01 CSCL 01/3

This report studies the application of a popular numerical technique, the Finite Difference Time Domain (FDTD) technique to the problem of scattering by conductor-backed dielectric plates, with cracks in the dielectric. Although previous efforts have only dealt successfully with frequencies that are relatively high, the technique presented in this report is applicable at low frequencies (i.e., where the crack is small with respect to wavelength). The formalism presented requires a relatively minor change in the basic FDTD technique. The first section presents a brief overview of some electromagnetic numerical techniques as applied to dielectric structures. This is followed by an introductory section on the basics of the FDTD technique. Next, the FDTD technique is extended so that it can model thin dielectric sheets. This is followed by a discussion of the extension of the FDTD technique to conductor-backed dielectric sheets. Finally, the complete model of conductor-backed dielectric sheets with cracks is presented. GRA

N89-26135# Arcon Corp., Waltham, MA.
LARGE MATRIX SOLUTION TECHNIQUES APPLIED TO AN ELECTROMAGNETIC SCATTERING PROBLEM Interim Report, Aug. 1986 - Jun. 1988
Margaret B. Woodworth Nov. 1988 35 p
(Contract F19628-86-C-0104)
(AD-A206917; RADC-TR-88-268) Avail: NTIS HC A03/MF A01 CSCL 20/3

There are many numerical applications where one must solve a large system of linear equations. In order to do this, two issues must be addressed: Storage of the large matrices and finding an efficient technique to solve this large system of equations. This report looks at these issues as they apply to a given electromagnetic scattering problem. Surface integral equations are solved to find the surface currents and the far-field scattering from a three-dimensional conducting cube. This three-dimensional scattering problem is solved by Magnetic-Field Integral Equations (MFIE), Augmented Magnetic-Field Integral Equations (AMFIE), or, the recently developed, dual-surface magnetic-field integral equations. Various methods are reported for dealing with the shortage of memory - Unified Extended Memory (UEM), virtual memory, mass storage, and direct access fields. These methods can be used to increase the size of available matrix memory, without vastly increasing the CPU time beyond the time that would be required with central memory alone. Three techniques of matrix solution are discussed: Gaussian elimination, the conjugate gradient, and the biconjugate gradient methods. The computations reported here were done on three representative scientific computers: A Cyber 860 with NOS 2.5 operating system, a VAX 8650 and a Vax 11/780. Both Vaxes have Vax/VMS version 4.7 operating system. GRA

N89-26136# Washington Univ., Saint Louis, MO. Electronic Systems and Signals Research Lab.
HIGH RESOLUTION RADAR IMAGING Semiannual Progress Report, 1 Jun. - 30 Nov. 1988
Donald L. Snyder 30 Nov. 1988 32 p
(Contract N00014-86-K-0370)
(AD-A206931) Avail: NTIS HC A03/MF A01 CSCL 17/9

The goal of this project is to formulate and investigate new approaches for forming images of radar targets from spotlight-mode, delay-doppler measurements. These measurements could be acquired with a high-resolution radar-imaging system operating with an optical-or radio-frequency carrier. Two approaches are under study. The first is motivated by an image-reconstruction algorithm used in radionuclide imaging called the confidence-weighted algorithm; here, we will refer to this approach as the chirp-rate modulation approach. The second approach is based on more fundamental principles which starts with a mathematical model that accurately describes the physics of an imaging radar-system and then uses statistical-estimation theory with this model to derive processing algorithms; we will

refer to this as the estimation-theory approach. Progress during this reporting period has been made on: (1) extending the estimation-theory approach to include a constraint on input signal-to-noise ratio; (2) extending the estimation-theory approach to include a sieve constraint for stabilizing image estimates, (3) extending the estimation-theory approach to include a specular or glint component in the radar-echo data; (4) analyzing the performance of the estimation-theory approach through computer simulations; and (5) modifying the chirp-rate modulation approach through the introduction of the Wigner-Ville distribution. A patent was awarded associated with the chirp-rate modulation approach. GRA

N89-26137# Booz-Allen and Hamilton, Inc., Bethesda, MD.
THE EFFECTS OF HIGH-ALTITUDE ELECTROMAGNETIC PULSE (HEMP) ON TELECOMMUNICATIONS ASSETS: TECHNICAL INFORMATION BULLETIN 88-3 Final Report
Jun. 1988 114 p Supersedes NCS-TIB-87-15
(Contract DCA100-87-C-0063; Proj. Q019)
(AD-A206952; NCS-TIB-88-3; NCS-TIB-87-15) Avail: NTIS HC A06/MF A01 CSCL 25/3

The objective of the Electromagnetic Pulse (EMP) Mitigation Program is the removal of EMP as a significant impediment to timely reestablishment of regional and national telecommunications following an attack against the United States that includes high-altitude nuclear detonations. The program approach involves estimating the effects of High-altitude EMP (HEMP) on telecommunication connectivity and traffic handling capability, assessing the impact of available HEMP mitigation alternatives, and developing a comprehensive plan for implementating mitigation alternatives. Available test results are summarized as they apply to the EMP Mitigation Program, and supercedes all previous versions of this report. GRA

N89-26138# Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
FINDING ACOUSTIC REGULARITIES IN SPEECH: APPLICATIONS TO PHONETIC RECOGNITION
James R. Glass Dec. 1988 155 p
(Contract N00014-82-K-0727; ARPA Order 4585)
(AD-A207072; TR-536) Avail: NTIS HC A08/MF A01 CSCL 05/7

Phonetic recognition can be viewed as a process through which the acoustic signal is mapped to a set of phonological units used to represent a lexicon. Traditionally, researchers often prescribe an intermediate, phonetic description to account for coarticulation. An alternative approach is presented whereby this phonetic-level description is bypassed in favor of directly relating the acoustic realization to the underlying phonemic forms. In this approach, the speech signal is transformed into a set of segments which are described completely in a acoustic terms. Next, these acoustic segments are related to the phonemes by a grammar which is determined using automated procedures operating on a set of training data. Thus important acoustic regularities that describes contextual variations are discovered without the need to specify a set of preconceived units such as allophones. The viability of this approach depends critically on the ability to detect important acoustic landmarks in the speech signal, and to describe these events in terms of an inventory of labels that captures the regularity of phonetic variations. GRA

N89-26139# SRI International Corp., Menlo Park, CA.
PROPAGATION DIAGNOSTICS MEASUREMENTS. MICROWAVE DIAGNOSTICS OF THE ATA ELECTRON BEAM PROPAGATING IN AIR Final Technical Report, 22 Apr. 1985 - 21 Apr. 1988
K. R. Stalder, M. S. Williams, and D. J. Eckstrom 22 Aug. 1988 46 p
(Contract N60921-85-C-0170; ARPA Order 4395; SRI Proj. PYU-8606)
(AD-A207124; SRI-MP-88-213) Avail: NTIS HC A03/MF A01 CSCL 20/3

Experiments on conductivity profiling around a propagating electron beam were successfully performed during the Spring 1987 series of open-air propagation experiments on ATA at LLNL. The measurements consisted of both 10- and 35-GHz microwave interferometers measurements of real and imaginary conductivity histories along chords at various y-offsets from the beam centerline and at two different locations along the propagating beam line. GRA

N89-26140# Department of the Army, Washington, DC.
DOUBLE-SIDED CO-AXIAL LASER Patent Application
Stephen D. Russell, inventor (to Army) 17 Jan. 1989 8 p Filed 17 Jan. 1989
(AD-D014086; US-Patent-Appl-SN-297893) Avail: NTIS HC A02/MF A01 CSCL 09/1

The solid metal current return in a typical commercial co-axial flashlamp is replaced with a light transmissive current return which permits light from either or both surfaces of the flashlamp to be used to pump dye volumes. This enables one flashlamp to pump two dye volumes simultaneously, resulting in a significant increase in the overall efficiency of the co-axial flashlamp-pumped dye laser. GRA

N89-26141# Technische Univ., Eindhoven (Netherlands). Electrical Energy Systems Group.
COMPARISON OF AN ANALYTICAL STUDY AND EMTP IMPLEMENTATION OF COMPLICATED THREE-PHASE SCHEMES FOR REACTOR INTERRUPTION
V. K. I. Kalasek Nov. 1988 33 p
(EUT-88-E-204; ISBN-90-6144-204-4; ISSN-0167-9708; ETN-89-94792) Avail: NTIS HC A03/MF A01

An analytical study and EMTP (ElectroMagnetic Transient Program) implementation for calculation of overvoltages in three-phase inductive circuits are compared. Capacitive and/or inductive couplings between phases are included in schemes with grounded and nongrounded neutrals. If the time steps for numerical integration are small enough, the EMTP calculation gives reliable and even more detailed and complete results than the analytical approach. Complete listings of input files for the EMTP program are given. ESA

N89-26142# Technische Univ., Eindhoven (Netherlands). Electromagnetism and Circuit Theory Group.
FINITE WORDLENGTH IN DIGITAL FILTERS: A REVIEW
H. J. Butterweck, J. H. F. Ritzerfeld, and M. J. Werter Oct. 1988 97 p
(EUT-88-E-205; ISBN-90-6144-205-2; ISSN-0167-9708; ETN-89-94793) Avail: NTIS HC A05/MF A01

Work on quantization and overflow effects in digital filters is reviewed. These unwanted nonlinear phenomena include parasitic oscillations (limit cycles) and quantization noise. Stabilization methods and noise optimization strategies are discussed. A bibliography (450 refernces) indicates contributions dealing with the analysis of various finite wordlength effects and measures to reduce or avoid them. ESA

33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

N89-26143*# Michigan Univ., Ann Arbor. Solid-State Electronics Lab.
MICROWAVE AND MILLIMETER-WAVE POWER GENERATION IN SILICON CARBIDE (SiC) IMPATT DEVICES Final Report, 1 Nov. 1984 - 26 Jun. 1988
I. Mehdi, George I. Haddad, and R. K. Mains Jun. 1989 28 p
(Grant NAG3-168)

(NASA-CR-185050; NAS 1.26:185050) Avail: NTIS HC A03/MF A01 CSCL 09C

There are two points that should be noted. First, in the thermal resistance calculations it is assumed that the device is operating at 773 K while the results of the room temperature simulations are used. This was done because there is not enough information to correctly predict the material parameters at 773 K. Since, in general, device performance degrades with increasing temperature, the cw results are perhaps a bit optimistic. Second, the electric field in these structures gets extremely high and there might be some possibility of tunneling. This was not incorporated into the simulation. Again, this could result in different device operating conditions. Author

N89-26144*# Texas A&M Univ., College Station. Dept. of Chemical Engineering.
A MATHEMATICAL MODEL OF A LITHIUM/THIONYL CHLORIDE PRIMARY CELL
T. I. Evans, T. V. Nguyen, and R. E. White Aug. 1987 51 p Submitted for publication
(Grant NAG9-177)
(NASA-CR-185083; NAS 1.26:185083) Avail: NTIS HC A04/MF A01 CSCL 10C

A 1-D mathematical model for the lithium/thionyl chloride primary cell was developed to investigate methods of improving its performance and safety. The model includes many of the components of a typical lithium/thionyl chloride cell such as the porous lithium chloride film which forms on the lithium anode surface. The governing equations are formulated from fundamental conservation laws using porous electrode theory and concentrated solution theory. The model is used to predict 1-D, time dependent profiles of concentration, porosity, current, and potential as well as cell temperature and voltage. When a certain discharge rate is required, the model can be used to determine the design criteria and operating variables which yield high cell capacities. Model predictions can be used to establish operational and design limits within which the thermal runaway problem, inherent in these cells, can be avoided. Author

N89-26145# Aquanautics Corp., Alameda, CA.
LONG ENDURANCE UNDERWATER POWER SYSTEM
Quarterly Report, Oct. - Dec. 1988
28 Jan. 1989 50 p
(Contract N00014-87-C-0335)
(AD-A205473) Avail: NTIS HC A03/MF A01 CSCL 10/3

The development and design of deep sea power sources for long endurances (more than 1 year) and moderate power (more than 1 KW) are unique. The best primary battery (Li-thionyl chloride) would involve huge space and weight and the cost of such a system would be prohibitive. Fuel cells with stored gases need a pressure vessel and also quite a large volume and weight. Aquanautics is engaged in developing a power source to a very demanding design. The design would involve a completely open system eliminating the need for a pressure vessel. Aquanautics will capture oxygen from the seawater to be delivered to a fuel cell. The hydrogen generated in this design is envisioned to be from a reaction between aluminum and seawater. Such a completely open system is already available from Alupower, Inc. This provides for a much safer and more compact design than cryogenic hydrogen. Lithium or magnesium can also be used. Both are expensive and lithium is known to be potentially hazardous. Since the last report, there has been major improvement of the technological issue of carrier longevity. The previous carrier had an operational life of 3 days. At present, Aquanautics has discovered a carrier called 23SuzyP which has stable electrochemical performance for over a month. GRA

N89-26146 Department of the Air Force, Washington, DC.
WAVEGUIDE TO STRIPLINE TRANSITION ASSEMBLY Patent
Darrel F. Sedivec, inventor (to Air Force) 28 Jun. 1988 5 p Filed 19 Dec. 1986
(AD-D013977; US-Patent-4,754,239; US-Patent-Appl-SN-943348)
Avail: US Patent and Trademark Office CSCL 09/1

The transition between a rectangular waveguide and a stripline is accomplished with an assembly which contains: a waveguide flange, a waveguide section, and a tapered wedge. The waveguide flange physically connects with the rectangular waveguide and the waveguide section. The waveguide section has the tapered wedge housed within it along its top, and is electrically connected to the ground planes of the stripline. The tapered wedge is electrically connected with the center conductor of the stripline, to provide a transition between the rectangular waveguide and the stripline. Optimum impedance matching and voltage standing wave ratio can be empirically determined in the assembly by inputting signals into the stripline or waveguide, and taking impedance measurements while moving a reflecting panel which rests behind the tapered wedge to different positions in the slotted waveguide section. GRA

N89-26147 Department of the Air Force, Washington, DC.
METHOD FOR FABRICATING LOW LOSS CRYSTALLINE SILICON WAVEGUIDES BY DIELECTRIC IMPLANTATION Patent
Joseph P. Lorenzo, inventor (to Air Force) and Richard A. Soref, inventor (to Air Force) 6 Dec. 1988 8 p Filed 26 Mar. 1987
(AD-D013987; US-Patent-4,789,642; US-Patent-Appl-SN-032810)
Avail: US Patent and Trademark Office CSCL 09/1

A method of fabricating low loss silicon optical waveguides by high energy ion implantation (which converts a buried region into dielectric material) is presented. The top silicon surface can then be etched or formed into waveguides that are isolated by the buried dielectric. Annealing of the top silicon layer can be used to improve optical quality and additional silicon can be added to the top surface waveguides by epitaxial growth. GRA

N89-26148*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DISTORTION AND REGULATION CHARACTERIZATION OF A MAPHAM INVERTER
Richard C. Sundberg, Andrew S. Brush, Robert M. Button, and Alexander G. Patterson (Analex Corp., Cleveland, OH.) Aug. 1989 10 p Presented at the 24th Intersociety Energy Conversion Engineering Conference, Washington, DC, 6-11 Aug. 1989; sponsored in part by IEEE, AIAA, ANS, ASME, SAE, ACS, and AIChE
(NASA-TM-102089; E-4854; NAS 1.15:102089) Avail: NTIS HC A02/MF A01 CSCL 09C

Output voltage Total Harmonic Distortion (THD) of a 20kHz, 6kVA Mapham resonant inverter is characterized as a function of its switching-to-resonant frequency ratio, f sub s/f sub r, using the EASY5 engineering analysis system. EASY5 circuit simulation results are compared with hardware test results to verify the accuracy of the simulations. The effects of load on the THD versus f sub s/f sub r ratio is investigated for resistive, leading, and lagging power factor load impedances. The effect of the series output capacitor on the Mapham inverter output voltage distortion and inherent load regulation is characterized under loads of various power factors and magnitudes. An optimum series capacitor value which improves the inherent load regulation to better than 3 percent is identified. The optimum series capacitor value is different than the value predicted from a modeled frequency domain analysis. An explanation is proposed which takes into account the conduction overlap in the inductor pairs during steady-state inverter operation, which decreases the effective inductance of a Mapham inverter. A fault protection and current limit method is discussed which allows the Mapham inverter to operate into a short circuit, even when the inverter resonant circuit becomes overdamped. Author

N89-26149*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FREQUENCY DOMAIN MODEL FOR ANALYSIS OF PARALLELED, SERIES-OUTPUT-CONNECTED MAPHAM INVERTERS
Andrew S. Brush, Richard C. Sundberg (General Dynamics Corp., San Diego, CA.), and Robert M. Button Aug. 1989 8 p Presented at the 24th Intersociety Energy Conversion Engineering Conference,

Washington, DC, 6-11 Aug. 1989; sponsored in part by IEEE, AIAA, ANS, ASME, SAE, ACS, and AIChE
(Contract NAS3-25266)
(NASA-TM-102140; E-4939; NAS 1.15:102140) Avail: NTIS HC A02/MF A01 CSCL 09A

The Mapham resonant inverter is characterized as a two-port network driven by a selected periodic voltage. The two-port model is then used to model a pair of Mapham inverters connected in series and employing phasor voltage regulation. It is shown that the model is useful for predicting power output in paralleled inverter units, and for predicting harmonic current output of inverter pairs, using standard power flow techniques. Some examples are compared to data obtained from testing hardware inverters.
Author

N89-26150*# Sverdrup Technology, Inc., Cleveland, OH.
PARALLELING POWER MOSFETS IN THEIR ACTIVE REGION: EXTENDED RANGE OF PASSIVELY FORCED CURRENT SHARING Final Report
Janis M. Niedra Jul. 1989 14 p
(Contracts NAS3-24105; NAS3-25266)
(NASA-CR-180902; E-4910; NAS 1.26:180902) Avail: NTIS HC A03/MF A01 CSCL 09A

A simple passive circuit that improves current balance in parallelled power MOSFETs that are not precisely matched and that are operated in their active region from a common gate drive are exhibited. A nonlinear circuit consisting of diodes and resistors generates the differential gate potential required to correct for unbalance while maintaining low losses over a range of current. Also application of a thin tape wound magnetic core to effect dynamic current balance is reviewed, and a simple theory is presented showing that for operation in the active region the branch currents tend to revert to their normal unbalanced values even if the core is not driven into saturation. Results of several comparative experiments are given.
Author

N89-26151# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
PROBLEMS OF PROVIDING JOINT OPERATION OF RADIO-ELECTRONIC EQUIPMENT (SELECTED PORTIONS)
A. D. Knyazev and V. F. Pchelkin 17 Mar. 1989 200 p Transl. into ENGLISH from Problemy Obespecheniya Sovmestnoy Raboty Radioelektronnoy Apparatury Nr. 6 (Moscow, USSR, Sovetskoye Radio), 1971 p 1-60; 142-200
(AD-A206585; FTD-ID(RS)T-1112-88) Avail: NTIS HC A09/MF A01 CSCL 09/1

A number of questions is examined which are connected with resolution of problem of electromagnetic compatibility of radio-electronic equipment (RES) of different designation/purpose, caused by continuously growing requirement, of radio frequencies for RES with simultaneous increase in radiated power and increase in sensitivity of receiving devices. Part of the material is dedicated to questions of the distribution of radio frequencies. The examination of nonbasic/minority emissions of RES and nonbasic/minority channels of reception occupies large portion. Questions of the calculation of the levels of radio interferences are presented. For the first time in concentrated form the existing norms and recommendations directed at the limitation of the level of radio interferences are given. Pamphlet is designed for wide circle of radio specialists, who work in field of design, production and operation of RES and their HF elements, and also in instructors and students of radio engineering call.
GRA

N89-26152# Cornell Univ., Ithaca, NY. Dept. of Materials Science and Engineering.
STRUCTURES FOR HIGH FREQUENCY TRANSISTOR Final Report, Aug. 1983 - Aug. 1987
L. F. Eastman, J. Wendt, J. W. Mayer, and K. Kavanaugh Feb. 1989 106 p
(Contract N66001-83-C-0304; ARPA Order 4736)
(AD-A206658; NOSC/TD-1485) Avail: NTIS HC A06/MF A01 CSCL 20/12

Submicron vertical electron flow structures were grown by Molecular Beam Epitaxy (MBE) with and without ballistic electron launchers. Both electron flow down toward the substrate and up away from the substrate were studied. Angle evaporation of metal, on the sides of etched vertical channels, was used to form Schottky gates. The placement of the gates at the launch plane for ballistic electrons was found to be critical. Ohmic contacts with improved performance and stability on n-type GaAs were studied using poly-Si on GaAs, Co on GaAs, and epitaxial Ge on GaAs.
GRA

N89-26153# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
NANOSECOND PULSE TECHNIQUE
L. A. Morugin and G. V. Glebovich 17 Mar. 1989 1023 p Transl. into ENGLISH of Nanosekundnaya Impulsnaya Tekhnika, Moscow (USSR), 1964 623 p
(AD-A206768; FTD-ID(RS)T-0767-88) Avail: NTIS HC A99/MF A03 CSCL 20/14

Bases of theory, methods and principles of nanosecond pulse techniques are examined, physical processes are illuminated, calculations of specific diagrams and elements are presented, technical characteristics of devices are given. Areas of study are: Transient Processes in Transmission Lines; Transient Processes in Transmission Lines with the Discrete Heterogeneities. Transformation of Pulses; Impulse Shaping in Linear Distributed Circuits; Impulse Shaping from the Shock Electromagnetic Waves, Which are Propagated in the Lines of Transmission; Pulsing in RC-Circuits with Feedback; Pulsing in Circuits with Inductive Feedback. Recirculators; Pulsing in Solid-State Circuits with Negative Resistance; Other methods of Impulse Shaping; Amplification of Pulses; Oscillography of Pulses; and Measurements of Parameters of Pulses.
GRA

N89-26154# Clarkson Univ., Potsdam, NY. Div. of Research.
SURFACE AND VOLUME EFFECTS OF MOISTURE Final Technical Report, Aug. 1986 - Mar. 1987
Didier Kane and Henry Domingos Jul. 1988 24 p
(Contract F30602-81-C-0206)
(AD-A206804; Rept-375-491; RADC-TR-88-153) Avail: NTIS HC A03/MF A01 CSCL 09/1

The work presented gives an understanding of the interaction modes between moisture and the materials used in the manufacture of the major commercially available moisture sensors for microelectronics. Chemisorption, physical adsorption and absorption of water vapor on silicon oxide and aluminum oxide were studied on a theoretical basis. A thermal characterization of these materials by Differential Scanning Analysis (DSC) and Moisture Evolution Analysis (MEA) was done to assess the limits of their applicability for moisture measurement in microelectronic packages. It was determined that thermal silicon dioxide is stable during package assembly while aluminum oxide exhibits a structural change at 360 C, which can affect the sensitivity of the volume effect sensors when exposed to higher temperatures.
GRA

N89-26155# David Sarnoff Research Center, Princeton, NJ.
HIGH-FILL-FACTOR 160 X 244-ELEMENT AND 320 X 244-ELEMENT PtSi SCHOTTKY-BARRIER IR-CCD IMAGE SENSORS Final Report, 23 Sep. 1985 - 30 Sep. 1987
W. F. Kosonocky, F. V. Shallcross, T. S. Villani, G. M. Meray, R. Miller, J. V. Groppe, and J. J. ONeill, III Oct. 1988 72 p
(Contract F19628-85-C-0187)
(AD-A206822; RADC-TR-88-130) Avail: NTIS HC A04/MF A01 CSCL 17/5

Two high-fill factor IR-CCD imagers, with PtSi Schottky-barrier detectors, were successfully demonstrated. The 160-element x 244-element imager has 80 micron x 40 micron pixels, with a fill factor of 60 percent, and a saturation signal of up to 2,500,000 electrons/pixel. For operation with a 300-K background, 30 frame/s, f/2.35 cold shield, and a 3.4 micron long-pass filter, a noise equivalent temperature (NE Delta T) of 0.04 C was measured for this imager. The 320-element x 244-element imager has 40 micron x 40 micron pixels, a fill factor of 43 percent, and a saturation signal of up to 1.5 x 10 to the 6th power electrons/pixel. For operation with a 300K background, 30 frames/s, and f/2.0 cold

shield, a shot-noise-limited NE Delta T of 0.038 C was measured for this imager. Both of the above imagers show no loss of horizontal and vertical resolution due to charge-transfer inefficiency for operation of the serial output register with a 2-phase CCD clock. This report describes the design, processing, operation and performance of the new 160 x 244 and 320 x 244 IR-CCD imagers. GRA

N89-26156# North Carolina Univ., Chapel Hill. Dept. of Chemistry.
SILICON OXIDATION STUDIES ON THIN FILM SILICON OXIDATION FORMATION Interim Technical Report
Eugene A. Irene 14 Mar. 1989 16 p
(Contract N00014-89-J-1178)
(AD-A206835; TR-23) Avail: NTIS HC A03/MF A01 CSCL 09/1

The formation of thin silicon dioxide films via thermal oxidation on single crystal Si substrates has been found to depend on the method of Si cleaning, impurities on the Si surface, the Si crystal orientation, film stress, and the availability of electrons at the Si surface. Recent studies on these topics are recounted along with a framework for understanding. No fully acceptable model for thin Si02 formation yet exists, but recent studies lead in new directions towards this goal. GRA

N89-26157# Michigan State Univ., East Lansing. Div. of Engineering Research.
ELECTROMAGNETIC INTERACTIONS IN HIGH-SPEED INTEGRATED ELECTRONIC CIRCUITS Final Report, 1 Jun. 1986 - 31 Dec. 1988
Dennis P. Nyquist 31 Mar. 1989 96 p
(Contract N00014-86-K-0609)
(AD-A206882) Avail: NTIS HC A05/MF A01 CSCL 09/1

The objective of this research was to investigate electromagnetic interactions among components within microstrip-based circuits fabricated adjacent to the layered surround characteristic of a high-speed MMIC environment. EM fields maintained by currents immersed in layered dielectric/ferrimagnetic media are exploited to study the complete propagation-mode spectrum of microstrip lines and their interactions with the coupled microstrip devices which they interconnect. Topics studied include: (1) electromagnetics of layered dielectric/ferrimagnetic media; (2) mathematical methods-analytical and numerical; (3) EM interactions among integrated microstrip guiding structures; (5) coupling between adjacent microstrip lines; (6) EM response of microstrip patch devices and antennas; and (7) experimental measurement of EM interactions in MMIC's. GRA

N89-26158# Ortel Corp., Alhambra, CA.
BAND STRUCTURE ENGINEERING FOR ULTRA-LOW THRESHOLD LASER DIODES
I. Ury and Kam Y. Lau 1988 7 p
(Contract N00014-88-C-0611)
(AD-A206932) Avail: NTIS HC A02/MF A01 CSCL 09/1

It has been proposed that strained layer superlattice be used to reduce the effective mass of holes, thereby reducing the transparency electron density and subsequently the lasing threshold. In conventional bulk materials, the degeneracy of heavy and light hole bands at zone center means domination of the heavy hold band in hole occupation. It was known that by applying strain to the crystal, the degeneracy can be broken such that under a biaxial compressive stress, the light hole band is lifted above the heavy hole band in the k-vector directions parallel to the applied strain. Since the heavy hole is five times heavier than the light hole, the resultant effective hole mass can be reduced by a factor of 5. The strain can be built in by growing lattice mismatched InGaAs on GaAs substrate. Such lattice-mismatched epitaxial layers cannot be arbitrarily thick for it to be defect free, the maximum thickness being only about 100A. GRA

N89-26159# Washington Univ., Seattle. Lab. for Integrated Systems.
VLSI ARCHITECTURES AND CAD Semiannual Report No. 2, 15 Nov. 1988 - 3 Apr. 1989
Lawrence Snyder Apr. 1989 45 p
(Contract N00014-88-K-0453)
(AD-A207006; NW-LIS-89-23-02; TR-89-23-02) Avail: NTIS HC A03/MF A01 CSCL 12/6

Topics addressed include: Bit Serial vs Word Parallel Computers; Development of Wirelisp; Simframe: A Framework for Multimode Simulation; Behavioral Representation of Digital Systems; Timing Optimization of Multi-phase Sequential Logic; Adaptive Scripts for MIS; A Demonstration of the APEX Architecture; A Hardware Data Compressor; Reconfigurable Logic Arrays; Work on a Low Cost Testing Environment; Wirelisp: Graphical Programs for Digital System Design; and Ohmics: A Program to Check Ohmic Contacts. GRA

N89-26160# Utah Univ., Salt Lake City. Dept. of Materials Science and Engineering.
FILTER BANKS FOR POWER SPECTRUM ESTIMATION WITH A LOGARITHMICALLY UNIFORM FREQUENCY RESOLUTION Interim Report
Miklos Gratzl and Jiri Janata 17 Mar. 1989 28 p
(Contract N00014-87-K-0060)
(AD-A207087; TR-18) Avail: NTIS HC A03/MF A01 CSCL 09/1

Characteristics of different analog bandpass filter banks generating power spectra with a logarithmically uniform frequency resolution and a constant relative analysis bandwidth are discussed. Equivalent digital filters are derived for use with digital spectrum analyzers. As an example of application, an algorithm for digital third octave band analysis is demonstrated and used for evaluation of fluctuation power spectra characterizing the real part of impedance of standard RC circuits. GRA

N89-26161# Air Force Academy, CO. Research Lab.
A FUNDAMENTAL ELECTROCHEMICAL INVESTIGATION OF BROMOALUMINATE AND MIXED CHLORO-BROMOALUMINATE ROOM TEMPERATURE MOLTEN SALT SYSTEMS Technical Report, Jan. 1987 - Aug. 1988
Jeffrey A. Boon, John S. Wilkes, and John A. Lanning Mar. 1989 105 p
(AD-A207119; FJSRL-TR-89-0004) Avail: NTIS HC A06/MF A01 CSCL 10/3

In this project, the chemical and electrochemical properties of the bromoaluminate molten salt system were determined. With knowledge of the bromide system, the chemical and electrochemical properties of the mixed chloro-bromoaluminate molten salt system were determined, allowing further work on the applicability of these systems as electrolytes in high density electrical storage devices. The qualitative electrochemical behavior of the bromide and chloride systems were compared. The systems were found to behave similarly, but the basic bromide system had two oxidative processes, compared to the single process of the chloride system. The bromide system was also shown to have a smaller electrochemical voltage window. GRA

N89-26162# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
ELECTRICAL AND GAS-DYNAMIC CHARACTERISTICS OF AN ELECTRIC-ARC GAS HEATER
A. B. Ambrazevicius, P. Yu. Valatkevicius, R. M. Kezelis, and R. A. Juskevicius 7 Apr. 1989 22 p Transl. into ENGLISH from Trudy Akademii Nauk Litovskoy SSR, Seriya B, Khimiya, Tekhnika, Fizicheskaya Geografiya (USSR), no. 4(67), 1971 p 115-125
(AD-A207166; AD-E501097; FTD-ID(RS)T-1128-88) Avail: NTIS HC A03/MF A01 CSCL 20/13

An investigation and generalization are made of the volt ampere characteristics and thermal efficiency of a dc electric arc heater in a vortex layout with a power of 300 kW with a mixing chamber and lateral discharge of the untwisted jet. The heater operates in

the area of ascending volt ampere characteristics. The installation which was developed was used for investigating processes of turbulent heat exchange and resistance in high-temperature flows of argon, nitrogen, and air. GRA

N89-26163# Technische Univ., Eindhoven (Netherlands). Automatic System Design Group.
COST CALCULATION FOR INCREMENTAL HARDWARE SYNTHESIS M.S. Thesis
R. J. vanEngelshoven and R. vandenBorn Jun. 1988 70 p
(EUT-88-E-202; ISBN-90-6144-202-8; ISSN-0167-9708; ETN-89-94790) Avail: NTIS HC A04/MF A01

The incremental estimation of layout area for logic circuits is considered. The estimates are to be used during the automated synthesis of hardware structures. These estimates are used to compare circuits on their efficiency. The absolute accuracy of the estimate, with regard to the real area occupation of the circuit, is less important than the relative accuracy with respect to the other circuits in the comparison. Two estimation methods are investigated: one based on linear placement and the other based on a probabilistic estimation scheme. The former method estimates area by placing the components in a linear sequence with the interconnecting wires situated along this sequence. The area is then determined by the rectangle enclosing both the components and the wires. The linear placements are calculated incrementally: i.e., when a component is added to the circuit (part of) the old placement is reused. The second method is useful for very fast estimates on large circuits that have a stable average wire length. ESA

N89-26164# Technische Univ., Eindhoven (Netherlands). Faculty of Electrical Engineering.
EXTENSIVE TESTING OF AN ALGORITHM FOR TRAVELLING-WAVE-BASED DIRECTIONAL DETECTION AND PHASE-SELECTION BY USING TWONFIL AND EMTP
M. H. J. Bollen and G. A. P. Jacobs Oct. 1988 109 p
(EUT-88-E-206; ISBN-90-6144-206-0; ISSN-0167-9708; ETN-89-94794) Avail: NTIS HC A06/MF A01

An algorithm for traveling-wave-based directional detection (including phase selection) was studied for over 10,000 fault and nonfault situations by using a relatively simple network model called TWONFIL. Additional testing on an electromagnetic transient program model was performed for the most frequently occuring faults as well as for dangerous cases found from the TWONFIL-study. Threshold settings and cut-off frequencies needed for a reliable protection are found, as well as detection and selection times needed. A few situations prove not to be detectable, othes might lead to the generation of false tripping signals. ESA

N89-26165# Technische Univ., Eindhoven (Netherlands).
THE APPLICATION OF SPIRAL LENSES IN ELECTRON GUNS FOR CATHODE RAY TUBES Ph.D. Thesis
Tjerk Gerrit Spanjer 1989 181 p Sponsored by Philips International B.V., Eindovhen, Netherlands
(ETN-89-94872) Avail: NTIS HC A09/MF A01

The application of a glass gun and spiral lens in a cathode ray tube for projection television is described. The spiral lens is of 10 mm diameter, consisting of 6 helical segments with constant pitch. The combined spherical aberration of cathode lens and spiral lens is further reduced by the application of an aberration reducing triode, in which a Selective Prefocusing (SP) lens acting close to the crossover refracts the rays selectively. The electron-optical design of the beam-forming part was checked with a software package for electron optical calculations including space charge. The operation of the SP lens is clarified with the aid of phase-space diagrams resulting from numerical simulations. The simulations indicate that a marked improvement of the gun is possible at high currents by the introduction of selective prefocusing. Spot measurements demonstrate that under optimum operating conditions the spiral-lens gun achieves a fixed-focus 5 percent intensity spot size of 0.27 mm at a current of 4 mA, going down to 0.22 mm at 0.5 to 1 mA, and to 0.16 mm at 0.1 mA. This performance is more than 30 percent better than that obtained by conventional guns with electrostatic focusing. It is also shown that, due to the low spherical aberration of the spiral lens, the increase in spot size at high beam currents is more than a factor of 3 lower in the case of the spiral lens gun. ESA

N89-26166# Technische Univ., Eindhoven (Netherlands).
SUPPRESSION OF PARASITIC OSCILLATIONS DUE TO OVERFLOW AND QUANTIZATION IN RECURSIVE DIGITAL FILTERS Ph.D. Thesis
Michael Jozef Werter 1989 195 p
(ISBN-90-9002-583-9; ETN-89-94882) Avail: NTIS HC A09/MF A01

Methods to suppress zero-input and forced-response parasitic oscillations, which occur due to overflow and quantization in recursive digital filters were developed. The stability requirements in first-order, second-order, direct-form, wave, normal, and state-space digital filters were investigated. Freedom from parasitic oscillations is proved with the second Lyapunov method. This method starts with a properly chosen quadratic energy function, which is positive definite and time-decreasing without wordlength reduction. If, moreover, wordlength reduction lowers the energy for all possible states, this energy function is a Lyapunov function which guarantees freedom from parasitic oscillations. ESA

N89-26593*# General Electric Co., Houston, TX. Mission Integration Office.
SPACELAB LIFE SCIENCES-1 ELECTRICAL DIAGNOSTIC EXPERT SYSTEM
C. Y. Kao and W. S. Morris *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 169-183 (For primary document see N89-26578 20-63)
(Contract NAS9-17884)
Avail: NTIS HC A17/MF A01 CSCL 09C

34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

N89-26167# North Carolina State Univ., Raleigh.
AN EXPLICIT, UPWIND ALGORITHM FOR SOLVING THE PARABOLIZED NAVIER-STOKES EQUATIONS Ph.D. Thesis
John J. Korte 1989 127 p
Avail: NTIS HC A07/MF A01

An explicit, upwind algorithm was developed for the direct (noniterative) integration of the 3-D Parabolized Navier-Stokes (PNS) equations in a generalized coordinate system. The new algorithm uses upwind approximations of the numerical fluxes for the pressure and convection terms obtained by combining flux difference splittings (FDS) formed from the solution of an approximate Riemann Problem (RP). The approximate RP is solved using an extension of the method developed by Roe for steady supersonic flow of an ideal gas. Roe's method is extended for use with the 3-D PNS equations expressed in generalized coordinates and to include Vigneron's technique of splitting the streamwise pressure gradient. The difficulty associated with applying Roe's scheme in the subsonic region is overcome. The second-order upwind differencing of the flux derivatives are obtained by adding FDS to either an original forward or backward differencing of the flux derivative. This approach is used to modify an explicit MacCormack differencing scheme into an upwind differencing scheme. The second order upwind flux approximations, applied with flux limiters, provide a method for numerically capturing shocks without the need for additional artificial damping terms which require adjustment by the user. In addition, a cubic equation is derived for determining Vigneron's pressure splitting coefficient using the updated streamwise flux vector. Decoding the streamwise

flux vector with the updated value of Vigneron's pressure splitting coefficient improves the stability of the scheme. The new algorithm is demonstrated for 2-D and 3-D supersonic and hypersonic laminar flow test cases. Results are presented for the experimental studies of Holden and of Tracy. In addition, a flow field solution is presented for a generic hypersonic aircraft at a Mach number of 24.5 and angle of attack of 1 deg. The computed results compare well to both experimental data and numerical results from other algorithms. Computational times required for the upwind PNS code are approximately equal to an explicit PNS MacCormack's code and existing implicit PNS solvers. Author

N89-26168# National Aerospace Lab., Tokyo (Japan).
MECHANISMS OF ENDWALL LEAKAGE FLOWS AND THE ASSOCIATED LOSSES IN A LINEAR TURBINE ROTOR CASCADE WITH BLADE TIP-CLEARANCE
Atsumasa Yamamoto and Katsuyoshi Kaba Jun. 1988 23 p
(NAL-TR-985T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

The mechanisms of three-dimensional flows and of the associated losses occurring in the tip endwall region of a linear turbine cascade with tip-clearance are discussed. The clearance gap sizes and the cascade incidences were chosen as the most important variables affecting the mechanisms. Flows close to the endwall and inside the clearance were surveyed in great detail using a micro five-hole Pitot tube of 0.6 mm head size. The results gave very detailed information on the mechanisms, such as leakage flow vectors and pressure distributions throughout the clearance. Interaction of leakage flow with the endwall flow and their associated separation lines, effects of gap size and inlet flow angle on loss generation, and skewness of the three-dimensional endwall flows are also discussed. Author

N89-26169# National Aerospace Lab., Tokyo (Japan).
SECONDARY FLOWS AND LOSSES IN TWO TYPES OF STRAIGHT TURBINE CASCADES. PART 1-A: STATOR CASE
Atsumasa Yamamoto and Hiroyuki Nouse May 1988 17 p
(NAL-TR-974T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

Some experimental information on secondary flows and on the associated total pressure losses occurring within turbine cascades is given. Part 1 describes the mechanism of production and development of the loss caused by secondary flows in a straight stator cascade with a turning angle of about 65 deg. A full representation of superimposed secondary flow vectors and loss contours is given at fourteen serial traverse planes located throughout the cascade. The presentation shows the mechanism clearly. Distributions of static pressures and of the loss on various planes close to blade surfaces and close to an endwall surface are given to show the loss accumulation process over the surfaces of the cascade passage. Variation of mass-averaged flow angle, velocity and loss through the cascade, and evolution of overall loss from upstream to down stream of the cascade are also given. Part 2 describes the mechanism in a straight rotor cascade with a turning angle of about 102 deg. Author

N89-26170# National Aerospace Lab., Tokyo (Japan).
SECONDARY FLOWS AND LOSSES IN TWO TYPES OF STRAIGHT TURBINE CASCADES. PART 2-A: ROTOR CASE
Atsumasa Yamamoto, Hiroshi Usui, and Fujio Mimura May 1988 18 p
(NAL-TR-975T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

The detailed mechanism of secondary flows and the associated losses occurring within a straight stator cascade with a relatively low turning angle of about 65 deg is discussed. The significant contribution of secondary flows on the loss production process was shown only near the blade suction surface downstream from the cascade throat (Z/Cax=0.74) in which regional flows decelerated due to adverse pressure gradient. The same experimental analysis is applied to a straight rotor cascade with a much larger turning angle of 102 deg. Flow surveys were made at twelve traverse planes located throughout the rotor cascade. The larger turning results in a similar but much stronger contribution of the secondary flows on the loss developing mechanism. Evolution of overall loss starts quite early within the cascade, and the rate of the loss growth is much larger in the rotor than in the stator. Author

N89-26171# Argonne National Lab., IL. Reactor Analysis and Safety Div.
INTERFACIAL AREA MEASUREMENT METHODS
M. J. Tan and M. Ishii Feb. 1989 41 p Prepared in cooperation with Midwest Universities Energy Consortium, Chicago, IL
(Contract W-31109-eng-38)
(DE89-009693; ANL-89/5; MFRI-4) Avail: NTIS HC A03/MF A01

Knowledge of local specific interfacial area is required for analysis and prediction of transient and steady characteristics of two-phase flow systems using the two-fluid models. Based on a survey of published work on the subject of specific interfacial area, it is recognized that there is virtually no data base for local specific interfacial area. This report describes the ongoing development of experimental techniques for measurement of local specific interfacial area in gas-liquid and liquid-liquid two-phase systems. Mathematical relations between local specific interfacial area and measurable quantities are derived based on kinematics and geometry. Two methods for determining local specific interfacial area are identified; both entail detection of passage of interfaces through fixed locations in the flow field. A multiple-sensor electrical-resistivity-probe technique is being developed for determination of local specific interfacial area in vertical gas-liquid bubbly flows. The technique consists of simultaneous measurements at two or four locations in the two-phase flow field of the local electrical resistivity of the two-phase mixture. Methods for data analysis are described. Limitations of the technique are briefly discussed. DOE

N89-26172*# Cornell Univ., Ithaca, NY. School of Mechanical and Aerospace Engineering.
MULTIGRID CALCULATION OF THREE-DIMENSIONAL TURBOMACHINERY FLOWS Final Report, 1 Sep. 1985 - 30 Jan. 1989
David A. Caughey Jun. 1989 28 p Sponsored by NSF; IBM and Corporate Research Inst.
(Grant NAG3-645)
(NASA-CR-185332; NAS 1.26:185332; FDA-89-07) Avail: NTIS HC A03/MF A01 CSCL 20D

Research was performed in the general area of computational aerodynamics, with particular emphasis on the development of efficient techniques for the solution of the Euler and Navier-Stokes equations for transonic flows through the complex blade passages associated with turbomachines. In particular, multigrid methods were developed, using both explicit and implicit time-stepping schemes as smoothing algorithms. The specific accomplishments of the research have included: (1) the development of an explicit multigrid method to solve the Euler equations for three-dimensional turbomachinery flows based upon the multigrid implementation of Jameson's explicit Runge-Kutta scheme (Jameson 1983); (2) the development of an implicit multigrid scheme for the three-dimensional Euler equations based upon lower-upper factorization; (3) the development of a multigrid scheme using a diagonalized alternating direction implicit (ADI) algorithm; (4) the extension of the diagonalized ADI multigrid method to solve the Euler equations of inviscid flow for three-dimensional turbomachinery flows; and also (5) the extension of the diagonalized ADI multigrid scheme to solve the Reynolds-averaged Navier-Stokes equations for two-dimensional turbomachinery flows. K.C.D.

N89-26173*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
A CONSERVATIVE APPROACH FOR FLOW FIELD CALCULATIONS ON MULTIPLE GRIDS Progress Report, period ended 31 Mar. 1988
Monchai Kathong and Surendra N. Tiwari Apr. 1988 119 p

(Contract NCC1-68)
(NASA-CR-185313; NAS 1.26:185313) Avail: NTIS HC A06/MF A01 CSCL 20D

In the computation of flow fields about complex configurations, it is very difficult to construct body-fitted coordinate systems. An alternative approach is to use several grids at once, each of which is generated independently. This procedure is called the multiple grids or zonal grids approach and its applications are investigated in this study. The method follows the conservative approach and provides conservation of fluxes at grid interfaces. The Euler equations are solved numerically on such grids for various configurations. The numerical scheme used is the finite-volume technique with a three-state Runge-Kutta time integration. The code is vectorized and programmed to run on the CDC VPS-32 computer. Some steady state solutions of the Euler equations are presented and discussed. Author

N89-26174*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CFD IN THE CONTEXT OF IHPTET: THE INTEGRATED HIGH PERFORMANCE TURBINE TECHNOLOGY PROGRAM
Robert J. Simoneau and Dale A. Hudson (Air Force Wright Research and Development Center, Wright-Patterson AFB, OH.) 1989 17 p Presented at the 25th Joint Propulsion Conference, Monterey, CA, 10-12 Jul. 1989; cosponsored by the AIAA, ASME, SAE, and ASEE
(NASA-TM-102132; E-4868; NAS 1.15:102132; AIAA-89-2904) Avail: NTIS HC A03/MF A01 CSCL 20D

The Integrated High Performance Turbine Engine Technology (IHPTET) Program is an integrated DOD/NASA technology program designed to double the performance capability of today's most advanced military turbine engines as we enter the twenty-first century. Computational Fluid Dynamics (CFD) is expected to play an important role in the design/analysis of specific configurations within this complex machine. In order to do this, a plan is being developed to ensure the timely impact of CFD on IHPTET. The developing philosphy of CFD in the context of IHPTET is discussed. The key elements in the developing plan and specific examples of state-of-the-art CFD efforts which are IHPTET turbine engine relevant are discussed. Author

N89-26175*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FAR FIELD EXPANSION FOR ANISOTROPIC WAVE EQUATIONS
S. I. Hariharan and Thomas Hagstrom (State Univ. of New York, Stony Brook.) Jun. 1989 12 p
(NASA-TM-102112; E-4882; ICOMP-89-14; NAS 1.15:102112) Avail: NTIS HC A03/MF A01 CSCL 20D

A necessary ingredient for the numerical simulation of many time dependent phenomena in acoustics and aerodynamics is the imposition of accurate radiation conditions at artificial boundaries. The asymptotic analysis of propagating waves provides a rational approach to the development of such conditions. A far field asymptotic expansion of solutions of anisotropic wave equations is derived. This generalizes the well known Friedlander expansion for the standard wave operator. The expansion is used to derive a hierarchy of radiation conditions of increasing accuracy. Two numerical experiments are given to illustrate the utility of this approach. The first application is the study of unsteady vortical disturbances impinging on a flat plate; the second is the simulation of inviscid flow past an impulsively started cylinder. Author

N89-26176*# High Technology Corp., Hampton, VA.
HOMAR: A COMPUTER CODE FOR GENERATING HOMOTOPIC GRIDS USING ALGEBRAIC RELATIONS: USER'S MANUAL
Anutosh Moitra Washington NASA Jul. 1989 79 p
(Contract NAS1-18240)
(NASA-CR-4243; NAS 1.26:4243) Avail: NTIS HC A05/MF A01 CSCL 20D

A computer code for fast automatic generation of quasi-three-dimensional grid systems for aerospace configurations is described. The code employs a homotopic method to algebraically generate two-dimensional grids in cross-sectional planes, which are stacked to produce a three-dimensional grid system. Implementation of the algebraic equivalents of the homotopic relations for generating body geometries and grids are explained. Procedures for controlling grid orthogonality and distortion are described. Test cases with description and specification of inputs are presented in detail. The FORTRAN computer program and notes on implementation and use are included. Author

N89-26177*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPARATIVE THERMAL ANALYSIS OF THE SPACE STATION FREEDOM PHOTOVOLTAIC DEPLOYABLE BOOM STRUCTURE USING TRASYS, NEVADA, AND SINDA PROGRAMS
Joseph F. Baumeister (Analex Corp., Cleveland, OH.), Duane E. Beach, and Sasan C. Armand Jul. 1989 10 p Presented at the 19th Intersociety Conference on Environmental Systems, San Diego, CA, 24-26 Jul. 1989; sponsored in part by the Society of Automotive Engineers
(NASA-TM-102062; E-4819; NAS 1.15:102062) Avail: NTIS HC A02/MF A01 CSCL 20D

The proposed Space Station Photovoltaic Deployable Boom was analyzed for operating temperatures. The boom glass/epoxy structure design needs protective shielding from environmental degradation. The protective shielding optical properties (solar absorptivity and emissivity) dictate the operating temperatures of the boom components. The Space Station Boom protective shielding must also withstand the effects of the extendible/retractable coiling action within the mast canister. A thermal analysis method was developed for the Space Station Deployable Boom to predict transient temperatures for a variety of surface properties. The modeling procedures used to evaluate temperatures within the boom structure incorporated the TRASYS, NEVADA, and SINDA thermal analysis programs. Use of these programs led to a comparison between TRASYS and NEVADA analysis methods. Comparing TRASYS and NEVADA results exposed differences in the environmental solar flux predictions. Author

N89-26178*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MODELING OF PULSED PROPELLANT REORIENTATION
A. E. Patag, J. I. Hochstein (Washington Univ., Saint Louis, MO.), and D. J. Chato Jul. 1989 19 p Presented at the 25th Joint Propulsion Conference, Monterey, CA, 10-12 Jul. 1989; sponsored in part by AIAA, ASME, SAE, and ASEE
(Grant NAG3-578)
(NASA-TM-102117; AIAA-89-2727; E-4892; NAS 1.15:102117) Avail: NTIS HC A03/MF A01 CSCL 20D

Optimization of the propellant reorientation process can provide increased payload capability and extend the service life of spacecraft. The use of pulsed propellant reorientation to optimize the reorientation process is proposed. The ECLIPSE code was validated for modeling the reorientation process and is used to study pulsed reorientation in small-scale and full-scale propellant tanks. A dimensional analysis of the process is performed and the resulting dimensionless groups are used to present and correlate the computational predictions for reorientation performance. Author

N89-26179*# Yale Univ., New Haven, CT.
THEORETICAL STUDIES IN SUPPORT OF THE 3M-VAPOR TRANSPORT (PVTOS-) EXPERIMENTS Final Report
Daniel E. Rosner and David E. Keyes Jul. 1989 54 p
(Grant NAG3-898)
(NASA-CR-185122; NAS 1.26:185122) Avail: NTIS HC A04/MF A01 CSCL 20D

Results are reported for a preliminary theoretical study of the coupled mass-, momentum-, and heat-transfer conditions expected within small ampoules used to grow oriented organic solid (OS-)

films, by physical vapor transport (PVT) in microgravity environments. It is show that previous studies made restrictive assumptions (e.g., smallness of delta T/T, equality of molecular diffusivities) not valid under PVTOS conditions, whereas the important phenomena of sidewall gas creep, Soret transport of the organic vapor, and large vapor phase supersaturations associated with the large prevailing temperature gradients were not previously considered. Rational estimates are made of the molecular transport properties relevant to copper-phthalocyanine monomeric vapor in a gas mixture containing H2(g) and Xe(g). Efficient numerical methods have been developed and are outlined/illustrated here to making steady axisymmetric gas flow calculations within such ampoules, allowing for realistic realistic delta T/T(sub)w-values, and even corrections to Navier-Stokes-Fourier 'closure' for the governing continuum differential equations. High priority follow-on studies are outlined based on these new results. Author

N89-26180*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MESH REFINEMENT IN A TWO-DIMENSIONAL LARGE EDDY SIMULATION OF A FORCED SHEAR LAYER
R. W. Claus, P. G. Huang, and J. M. MacInnes (Princeton Univ., NJ.) Jun. 1989 20 p
(NASA-TM-102129; E-4844; NAS 1.15:102129) Avail: NTIS HC A03/MF A01 CSCL 20D

A series of large eddy simulations are made of a forced shear layer and compared with experimental data. Several mesh densities were examined to separate the effect of numerical inaccuracy from modeling deficiencies. The turbulence model that was used to represent small scale, 3-D motions correctly predicted some gross features of the flow field, but appears to be structurally incorrect. The main effect of mesh refinement was to act as a filter on the scale of vortices that developed from the inflow boundary conditions. Author

N89-26181*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TURBULENCE MODELING FOR HYPERSONIC FLOWS
J. G. Marvin and T. J. Coakley Jun. 1989 49 p Previously announced in IAA as A89-33641
(NASA-TM-101079; A-89060; NAS 1.15:101079) Avail: NTIS HC A03/MF A01 CSCL 20D

Turbulence modeling for high speed compressible flows is described and discussed. Starting with the compressible Navier-Stokes equations, methods of statistical averaging are described by means of which the Reynolds-averaged Navier-Stokes equations are developed. Unknown averages in these equations are approximated using various closure concepts. Zero-, one-, and two-equation eddy viscosity models, algebraic stress models and Reynolds stress transport models are discussed. Computations of supersonic and hypersonic flows obtained using several of the models are discussed and compared with experimental results. Specific examples include attached boundary layer flows, shock wave boundary layer interactions and compressible shear layers. From these examples, conclusions regarding the status of modeling and recommendations for future studies are discussed. Author

N89-26182*# University of Southern California, Los Angeles. Dept. of Aerospace Engineering.
LIQUID DROPLET GENERATION Final Report
E. P. Muntz, Melissa Orme, Tony Farnham, G. Pham VanDiep, and P. Huerre Jun. 1989 72 p
(Contract NAS3-25068)
(NASA-CR-182246; NAS 1.26:182246) Avail: NTIS HC A04/MF A01 CSCL 20D

A pre-prototype segment of a droplet sheet generator for a liquid droplet radiator was designed, constructed and tested. The ability to achieve a uniform, non-diverging droplet sheet is limited by manufacturing tolerances on nozzle parallelism. For an array of 100, 100 micrometer diameters nozzles spaced 5 stream diameters apart, typical standard deviations in stream alignment were plus or minus 10 mrad. The drop to drop fractional speed variations of the drops in typical streams were similar and independent of position in the array. The absolute value of the speed dispersion depended on the amplitude of the disturbance applied to the stream. A second generation preliminary design of a 5200 stream segment of a droplet sheet generator was completed. The design is based on information developed during testing of the pre-prototype segment, along with the results of an acoustical analysis for the stagnation cavity pressure fluctuations used to break-up the streams into droplets. Author

N89-26183*# Universities Space Research Association, Huntsville, AL.
A TWO-LAYER MULTIPLE-TIME-SCALE TURBULENCE MODEL AND GRID INDEPENDENCE STUDY
S.-W. Kim and C.-P. Chen (Alabama Univ., Huntsville.) Mar. 1989 17 p
(Contract NAS8-35918)
(NASA-CR-183653; NAS 1.26:183653) Avail: NTIS HC A03/MF A01 CSCL 20D

A two-layer multiple-time-scale turbulence model is presented. The near-wall model is based on the classical Kolmogorov-Prandtl turbulence hypothesis and the semi-empirical logarithmic law of the wall. In the two-layer model presented, the computational domain of the conservation of mass equation and the mean momentum equation penetrated up to the wall, where no slip boundary condition has been prescribed; and the near wall boundary of the turbulence equations has been located at the fully turbulent region, yet very close to the wall, where the standard wall function method has been applied. Thus, the conservation of mass constraint can be satisfied more rigorously in the two-layer model than in the standard wall function method. In most of the two-layer turbulence models, the number of grid points to be used inside the near-wall layer posed the issue of computational efficiency. The present finite element computational results showed that the grid independent solutions were obtained with as small as two grid points, i.e., one quadratic element, inside the near wall layer. Comparison of the computational results obtained by using the two-layer model and those obtained by using the wall function method is also presented. Author

N89-26184*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
WORKSHOP ON TWO-PHASE FLUID BEHAVIOR IN A SPACE ENVIRONMENT
Theodore D. Swanson, ed., Al Juhasz, ed., W. Russ Long, ed. (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), and Laura Ottenstein, ed. 1989 45 p Workshop held in Ocean City, MD, 13-14 Jun. 1988
(NASA-CP-3043; Rept-89B00114; NAS 1.55:3043) Avail: NTIS HC A03/MF A01 CSCL 20D

The Workshop was successful in achieving its main objective of identifying a large number of technical issues relating to the design of two-phase systems for space applications. The principal concern expressed was the need for verified analytical tools that will allow an engineer to confidently design a system to a known degree of accuracy. New and improved materials, for such applications as thermal storage and as heat transfer fluids, were also identified as major needs. In addition to these research efforts, a number of specific hardware needs were identified which will require development. These include heat pumps, low weight radiators, advanced heat pipes, stability enhancement devices, high heat flux evaporators, and liquid/vapor separators. Also identified was the need for a centralized source of reliable, up-to-date information on two-phase flow in a space environment. Author

N89-26185*# Colorado Univ., Boulder. Dept. of Aerospace Engineering Sciences.
A CHEBYSHEV MATRIX METHOD FOR SPATIAL MODES OF THE ORR-SOMMERFELD EQUATION Final Report
G. Danabasoglu and S. Biringen Washington Aug. 1989 16 p
(Grant NAG1-462)

(NASA-CR-4247; NAS 1.26:4247) Avail: NTIS HC A03/MF A01 CSCL 20D

The Chebyshev matrix collocation method is applied to obtain the spatial modes of the Orr-Sommerfeld equation for Poiseuille flow and the Blausius boundary layer. The problem is linearized by the companion matrix technique for semi-infinite domain using a mapping transformation. The method can be easily adapted to problems with different boundary conditions requiring different transformations. Author

N89-26186# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

CHARGED SLURRY DROPLET RESEARCH Final Report, 1 Oct. 1986 - 30 Sep. 1988

A. J. Kelly 20 Feb. 1989 201 p

(Grant AF-AFOSR-0013-86; AF Proj. 2308)

(AD-A206946; MAE-1855; AFOSR-89-0406TR) Avail: NTIS HC A10/MF A01 CSCL 07/4

Rayleigh Bursting, wherein critically charged droplets explosively expel a number of micron sized sibling droplets, enhances atomization and combustion of all liquid fuels. Droplet surface charge is retained during evaporation, permitting multiple Rayleigh Bursts to occur. Moreover, the charge is available for the deagglomeration of residual particulate flocs from slurry droplet evaporation. To fill gaps in our knowledge of these processes, an experimental program involving the use of a charged droplet levitator and a Quadrupole Mass Spectrometer, High Speed Electrometer (QMS/HSE) has been undertaken to observe the disruption and to measure quantitatively the debris. A charged droplet levitator based on a new video frame grabber technology to image transient events, is described. Sibling droplet size is ten microns or less and is close to, if not coincident with, the predicted phase transition in droplet charging level. The research effort has focused on the exploration of this transition and its implications. GRA

N89-26187# Scientific Research Associates, Inc., Glastonbury, CT.

RECIPROCAL INTERACTIONS OF HAIRPIN-SHAPED VORTICES AND A BOUNDARY LAYER Final Report, 1 Feb. 1986 - 31 Dec. 1988

N. S. Liu, S. J. Shamroth, and H. McDonald 31 Dec. 1988 296 p

(Contract F49620-86-C-0028)

(AD-A206980; SRA-R88-910016-F; AFOSR-89-0459TR) Avail: NTIS HC A13/MF A01 CSCL 20/4

The role of hairpin vortices in cyclic production of wall turbulence has been studied in many laboratory experiments, primarily by using flow visualization. Study of hairpin vortices in a fully turbulent environment is greatly complicated by the presence of jitters and other co-existing structures. A viable approach for obtaining better understanding of the role of hairpin vortices in turbulence dynamics is to study the flow events stimulated by synthetically generated hairpin vortices in initially laminar boundary layers. This study simulates the flow dynamics stimulated by hairpin-shaped vortices in a boundary layer through the solution of time-dependent, three-dimensional, compressible Navier-Stokes equations. The numerical scheme used leads to temperal-spatial simulations and could be easily applied to future simulations focusing upon the effects of pressure gradient and compressibility on turbulence structure. Two simulations were carried out. In the first case, the initial condition contains only one imposed hairpin-shaped vortex; in the second, there are two incipient vortices separated by a short distance in the streamwise direction. GRA

N89-26188# Wisconsin Univ., Madison. Center for Mathematical Sciences.

A FAST ALGORITHM FOR NON-NEWTONIAN FLOW. AN ENHANCED PARTICLE-TRACKING FINITE ELEMENT CODE FOR SOLVING BOUNDARY-VALVE PROBLEMS IN VISCOELASTIC FLOW Final Report, 1 Apr. 1985 - 30 Sep. 1988

David S. Malkus 5 Jan. 1989 41 p

(Grant AF-AFOSR-0141-85; AF Proj. 2304)

(AD-A206997; AFOSR-89-0381TR) Avail: NTIS HC A03/MF A01 CSCL 20/4

This project concerned the development of a new fast finite element algorithm to solve flow problems of non-Newtonian fluids such as solutions or melts of polymers. Many constitutive theories for such materials involve single integrals over the deformation history of the particle at the stress evaluation point; examples are the Doi-Edwards and Curtiss-Bird molecular theories and the BKZ family derived from continuum arguments. These theories are believed to be among the most accurate in describing non-Newtonian effects important to polymer process design, effects such as stress relaxation, shear thinning, and normal stress effects. This research developed an optimized version of the algorithm which would run a factor of two faster than the pilot algorithm on scalar machines and would be able to take full advantage of vectorization on machines. Significant progress was made in code vectorization; code enhancement and streamlining; adaptive memory quadrature; model problems for the High Weissenberg Number Problem; exactly incompressible projection; development of multimesh extrapolation procedures; and solution of problems of physical interest. A portable version of the code is in the final stages of benchmarking and testing. It interfaces with the widely used FIDAP fluid dynamics package. GRA

N89-26189# Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.

REPAIR, EVALUATION, MAINTENANCE AND REHABILITATION RESEARCH PROGRAM: EXPLICIT NUMERICAL ALGORITHM FOR MODELING INCOMPRESSIBLE APPROACH FLOW Final Report

Robert S. Bernard Mar. 1989 71 p

(AD-A207176; WES/TR/REMR-HY-5) Avail: NTIS HC A04/MF A01 CSCL 20/4

Adverse approach flow can increase the frequency of repair and the cost of maintenance while reducing the working life of a hydraulic structure. In many cases it is less expensive to modify the approach than to pay the long-term costs that would result from continued operation under existing flow conditions. Accordingly, the modifications themselves must be chosen to achieve the greatest benefit with the simplest and least expensive remedial measures. A new computer program, STREMR, is under development to aid scientists, mathematicians, and engineers in simulating complex approach flows. The STREMR code is a finite-difference numerical model for two-dimensional depth- or width-averaged flow with boundaries and obstacles of arbitrary shape. The existing formulation is a predictor-corrector scheme derived from MacCormack's method. As such, it is applicable for transient flow at low Froude number, and for steady-state subcritical flow at moderate Froude number. The algorithm has been incorporated in the STREMR computer program, which will allow engineers and scientists to simulate the effects of structural modifications and repair measures prior to physical testing. The results of essential benchmark calculations are included for verification. GRA

N89-26190# Rome Univ. (Italy). Dipartimento di Fisica.

SMALL SCALE STRUCTURE OF A PASSIVE SCALAR IN LAMINAR AND TURBULENT FLUIDS

Andrea Crisanti, Massimo Falcioni, Giovanni Paladin, and Angelo Vulpiani (Aquila Univ., Italy) 21 Dec. 1988 19 p Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy

(Preprint-646; ETN-89-94722) Avail: NTIS HC A03/MF A01

The subinertial range structure of convected quantities in incompressible fluids is studied. The classical theory of Batchelor, which gives the -1 power law for the power spectrum of a passive scalar at wavenumbers k, is revised. It is shown that the power law is related to chaotic motion of marker particles (Lagrangian chaos) and to the incompressibility constraint. It is stressed that the -1 power regime is also present in fluids which are not turbulent. The approach shows that Batchelor's law is valid for all dimensionalities equal to or greater than two. ESA

N89-26191# Institut Franco-Allemand de Recherches, Saint-Louis (France).
BOUNDARY LAYER AND HEAT TRANSFER GENERATED BY A PISTON LAUNCHED IN A SHOCK TUBE. PART 3: MODIFICATIONSS OF THE PISTON AND INTRODUCTION OF INERT PARTICLES Final Report [GRENZSCHICHT UND WAERMEUEBERGANG AM FLUGKOLBEN. TEIL 3: MASSNAHMEN AM KOLBEN UND ZUGABE INERTER PARTIKEL]
F. Seiler 5 Feb. 1988 57 p In GERMAN
(Contract BMVg-T/R-760/G-0009/G-1709)
(ISL-R-103/88-Pt-3; ETN-89-94854) Avail: NTIS HC A04/MF A01

Interior ballistic fluid flow is simulated by a piston launched in a shock tube. Wall heat transfer is analyzed as a factor of piston base geometry and split configuration simulating gas flow. Inert particle flow pattern and effects on wall temperature reduction is described. Results indicate that thermal load is not influenced by piston geometry. Temperature reduction is obtained by split profile adaptation and piston length diminution. ESA

N89-26192 Technische Univ., Delft (Netherlands).
ANALYSIS AND NUMERICAL SIMULATION OF THE FLOW OF VISCOELASTIC FLUIDS Ph.D. Thesis
Martinus Antonius Hulsen 1988 181 p
(ISBN-90-6275-494-5; ETN-89-94894) Copyright Avail: Delft Univ. Press, Stevinweg 1, 2628 CN Delft, Netherlands

The governing equations of viscoelastic flow are reviewed, and a numerical method for plane flow based on the finite-element method and streamline integration is presented. The numerical method is particularly suited for Jeffreys-type models. Iterative schemes for solving the equations are discussed. The numerical stability of the integration of the constitutive equations is studied. The internal deformation models have a much better stability than the quasi-linear models. Approximation errors of the numerical method are considered. The numerical method is used to compute the flow over a square cavity. The convergence behavior of the iterative scheme is analyzed. Results show that it is possible to compute viscoelastic flows with moderately high Deborah numbers, but the convergence of the iterative scheme is still very slow. ESA

N89-26193# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
A SOLUTION SCHEME FOR THE DENSITY EXPANSION OF THE EFFECTIVE THERMAL CONDUCTIVITY OF A RANDOM SUSPENSION OF SPHERES
P. vanBeek 1988 34 p
(Rept-88-70; ISSN-0922-5641; ETN-89-94901) Copyright Avail: NTIS HC A03/MF A01

A method which consists of a sequence of identical solution steps each of which increases by one the other of accuracy of the density expansion of the effective conductivity is presented. The method is based on a proposal by Batchelor to circumvent divergent integrals in the random sedimentation problem and is, as such, an alternative for the virial expansion method of Felderhof, Ford and Cohen (1982, 1983). Both methods yield the same two-particle approximation. To higher orders the precise relationship between the two methods is not yet established. ESA

N89-26194# Manchester Univ. (England). Dept. of Engineering.
NUMERICALLY DETERMINED TRANSITION IN SEPARATED INTERNAL FLOW
J. H. Gerrard Nov. 1987 8 p Presented at the AGARD Symposium on Fluid Dynamics of Three Dimensional Turbulent Shear Flows, Turkey, 3-6 Oct. 1988
(AERO-Rept-8708; ETN-89-94948) Avail: NTIS HC A02/MF A01

The oscillating axisymmetric flow in a conically tapered tube was studied experimentally and by numerical analysis. The investigation of transition to turbulence is concerned with the position in the tube and the phase at which turbulence occurs for the different flow parameters and is not an attempt to model the physical characteristics of the transition process. The axisymmetry of the solution constrains any numerically determined turbulence to be essentially two-dimensional which thus cannot model the three dimensional nature of real turbulence. The philosophy on which the method is based is than when a laminar flow is reasonably modeled by a numerical solution for a given set of boundary conditions one should expect something to happen to the computed flow when the real flow goes turbulent. This idea seems more plausible given that the large scales of turbulent motion bear a strong resemblance to laminar oscillations at lower Reynolds numbers. The method indicates that for this internal separated flow the transition to turbulence is reasonably predicted by a computation in which the numerical parameters have values in the range in which their alteration does not affect the conditions of breakdown. ESA

N89-26195# Manchester Univ. (England). Dept. of Aeronautical Engineering.
OSCILLATING FLOW IN TUBES OF SMALL CONICAL TAPER
G. Y. Buss, J. H. Gerrard, and C. N. Savvides Oct. 1987 69 p Submitted for publication Sponsored by the United Kingdom Science and Engineering Research Council and CNS, United Kingdom
(AERO-Rept-8709; ETN-89-94949) Avail: NTIS HC A05/MF A01

Flow visualization and numerical analysis were used to investigate the flow in a conical section of a rigid tube connected at each end to cylindrical tubes in which the flow was fully developed laminar pipe flow. Reversed flow in which the flow was from the narrow end towards the wide end of the conical section was studied. Taper semi-angles of 0.025 and 0.0034 radians were investigated. Most of the experiments were made in the tube of larger taper. The formation and development of a ring vortex in sinusoidally oscillating flow was analyzed. It is found that the principal parameter is the product of peak Reynolds number and the taper semi-angle; the Reynolds number is based on the maximum reversed flow rate and the diameter at the smaller end of the conical tube. The medical applications of the work to vascular disease are described. It is concluded that ring vortices are not produced in a normal femoral artery but only under conditions of constriction of the artery. The limit of the travel of the vortex up the tapered tube is found to be close to the position at which the human superficial femoral artery begins to be blocked. ESA

N89-26196# Manchester Univ. (England). Dept. of Engineering.
A PRELIMINARY INVESTIGATION INTO EULER METHODS FOR APPLICATION TO MULTI-ELEMENT AEROFOILS FOR HIGH LIFT Ph.D. Thesis
Michael L. Barber Nov. 1987 116 p
(AERO-Rept-8710; ETN-89-94950) Avail: NTIS HC A06/MF A01

The full potential equation is solved for flow past a circular cylinder and the results obtained are compared with the benchmark solution of Rayleigh and Janzen. Euler's equations of motion are derived in a Cartesian coordinate system. A general form of the equations for orthogonal curvilinear coordinate systems is also given. The equations in Cartesian coordinates are discretized. The main methods are those or Lax, MacCormack, and Hall. The first order finite difference technique and first and second order cell-vertex integral method are applied to the problem of a 10 percent symmetric thin airfoil in subsonic freestream. The results are compared to those or the linearized model. A flow solution over a circular cylinder is treated. The Euler equations are developed in inverted cylindrical polar coordinates. The inverse conformal mapping is used to map the exterior region of the circle onto the internal region. A subsonic freestream flow is considered for a leading quarter of the circle using the second order finite difference technique and the second order cell-vertex method. Results are compared with those obtained using the full-potential model. For a half-circle, results for a slightly supercritical freestream are given. ESA

N89-26197# Manchester Univ. (England). Dept. of Engineering.
A VISCOUS SPLITTING ALGORITHM APPLIED TO LOW REYNOLDS NUMBER FLOW ROUND A CIRCULAR CYLINDER
M. G. Benson, P. G. Bellamy-Knights, J. H. Gerrard, and I. Gladwell Jul. 1988 72 p Sponsored by the United Kingdom Science and Engineering Research Council
(AERO-Rept-8803; ETN-89-94954) Avail: NTIS HC A04/MF A01

The established method of splitting the equations of flow into separate convection and diffusion equations, the solutions of which are superposed to provide an approximate solution, is presented with a new vorticity diffusion treatment. Test cases which show the accuracy of the method in several simple flows are presented. The method is applied to low Reynolds number flows about circular cylinders with steady and oscillating wakes. The diffusion method involves a direct exact solution for the diffusion of vorticity at each time step followed by rediscretization onto a mesh of grid points. Comparison with a finite element solution and with experimental results shows good agreement up to a Reynolds number of 200, the extent of the range studied. ESA

35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

N89-26198*# EPITAXX, Inc., Princeton, NJ.
DEVELOPMENT OF A UNIQUE LABORATORY STANDARD: INDIUM GALLIUM ARSENIDE DETECTOR FOR THE 500-1700 nm SPECTRAL REGION Final Report
27 Aug. 1987 42 p
(Contract NAS5-30043)
(NASA-CR-183420; NAS 1.26:183420) Avail: NTIS HC A03/MF A01 CSCL 14B

A planar (5 mm diameter) indium gallium arsenide detector having a high (greater than 50 pct) quantum efficiency from the visible into the infrared spectrum (500 to 1700 nm) was fabricated. Quantum efficiencies as high as 37 pct at 510 nm, 58 pct at 820 nm and 62 pct at 1300 nm and 1550 nm were measured. A planar InP/InGaAs detector structure was also fabricated using vapor phase epitaxy to grow device structures with 0, 0.2, 0.4 and 0.6 micrometer thick InP caps. Quantum efficiency was studied as a function of cap thickness. Conventional detector structures were also used by completely etching off the InP cap after zinc diffusion. Calibrated quantum efficiencies were measured. Best results were obtained with devices whose caps were completely removed by etching. Certain problems still remain with these detectors including non-uniform shunt resistance, reproducibility, contact resistance and narrow band anti-reflection coatings. K.C.D.

N89-26199 Department of the Air Force, Washington, DC.
ION-SENSITIVE PHOTODETECTOR Patent
Kenneth P. Quinlan, inventor (to Air Force) 20 Dec. 1988 5 p Filed 1 Dec. 1986
(AD-D013989; US-Patent-4,792,836; US-Patent-Appl-SN-936195) Avail: US Patent and Trademark Office CSCL 09/1

A photodetector is presented which uses a modified ion-sensitive field effect transistor having a layer of photoactive material. Upon exposure to a beam of light the photoactive material produces a charge-separation (with proton movement) which affects the drain current. The change in gate voltage (needed to stabilize the drain current) is a measure of the intensity of the light input. GRA

N89-26200# National Inst. of Standards and Technology, Gaithersburg, MD.
ELECTRICAL PERFORMANCE TESTS FOR HAND-HELD DIGITAL MULTIMETERS Final Report
T. F. Leedy, K. J. Lentner, O. B. Laug, and B. A. Bell Jan. 1989 290 p
(PB89-162234; NISTIR-88/4021) Avail: NTIS HC A13/MF A01 CSCL 14B

Electrical performance test procedures for battery-powered, hand-held digital multimeters were developed for the purpose of evaluating samples submitted by electronic instrument manufacturers in response to specifications issued by the U.S. Army Communications-Electronics Command. The detailed, step-by-step test procedures are based on the Army specifications and include sample data sheets and tables for the recording of interim data and final test results. The measurement principles and techniques underlying each of the procedures are discussed. In addition, the sources of measurement uncertainty are discussed. Author

N89-26201*# Rhode Island Univ., Kingston.
THEORY AND APPLICATIONS OF OPTICAL FIBER LEVER SENSORS
F. W. Cuomo 1989 22 p
(Grant NAG1-519)
(NASA-CR-185344; NAS 1.26:185344) Avail: NTIS HC A03/MF A01 CSCL 14B

The evolution of optical fiber lever concepts is illustrated leading to several designs found useful in air and water applications. In particular, this technology has led to the development of underwater detectors of the pressure and pressure gradient kind. In addition, an optical microphone with features not found in condenser microphones has been utilized in the measurement of pressure fluctuations in high speed boundary layers requiring sensors of small size, extended bandwidth, wide dynamic range, and high temperature capability. Finally, similar concepts have been applied to the design of scale model acoustic arrays intended for acoustic imaging applications in the megahertz frequency range. Author

N89-26202* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DUAL WAVELENGTH HOLOGRAPHIC INTERFEROMETRY SYSTEM Patent
William K. Witherow, inventor (to NASA) and Andreas Ecker, inventor (to NASA) (European Space Agency, Paris, France) 29 Jan. 1988 5 p Filed 29 Jan. 1988
(NASA-Case-MFS-28242-1; US-Patent-4,810,094; US-Patent-Appl-SN-149822; US-Patent-Class-356-347; US-Patent-Class-356-361) Avail: US Patent and Trademark Office CSCL 14B

A two-wave holographic interferometry system and method is described. In such systems, a reference beam holographic is superimposed on an object beam, the object beam being an image obtained by passing a beam through an object regarding which some parameter (e.g., temperature gradient) is to be measured. A photograph of the superimposed beams is taken. This invention employs two object and two reference beams and the invention is particularly concerned with the use of a prism assembly which causes the two different wavelengths of the object beams to emerge from the prism at slightly different angles, thereby providing two holographic images which are slightly displaced from each other. Official Gazette of the U.S. Patent and Trademark Office

N89-26203*# Old Dominion Univ., Norfolk, VA.
TRANSIENT HOT-FILM SENSOR RESPONSE IN A SHOCK TUBE Final Report, 1988 - 1989
A. S. Roberts, Jr., K. R. Ortgies, and E. Gartenberg May 1989 83 p
(Grant NAG1-735)
(NASA-CR-181838; NAS 1.26:181838) Avail: NTIS HC A05/MF A01 CSCL 14B

Shock tube experiments were performed to determine the response of a hot-film sensor, mounted flush on the side wall of

a shock tube, to unsteady flow behind a normal shock wave. The present experiments attempt to isolate the response of the anemometer due only to the change in convective heat transfer at the hot-film surface. The experiments, performed at low supersonic shock speeds in air, are described along with the data acquisition procedure. The change in convective heat transfer is deduced from the data and the results are compared with those from transient boundary layer theory and another set of experimental results. Finally, a transient local heat transfer coefficient is formulated for use as the forcing function in a hot-film sensor instrument model simulation. Author

N89-26204*# Rockwell International Science Center, Anaheim, CA.
SOLID STATE PHOTOMULTIPLIER FOR ASTRONOMY, PHASE 2 Contractor Report, 30 Sep. 1987 - 10 Jun. 1988
P. J. Besser, K. M. Hays, and R. A. LaViolette May 1989 44 p
(Contract NAS2-12400)
(NASA-CR-177514; NAS 1.26:177514) Avail: NTIS HC A03/MF A01 CSCL 14B

Epitaxial layers with varying donor concentration profiles were grown on silicon substrate wafers using chemical vapor deposition (CVD) techniques, and solid state photomultiplier (SSPM) devices were fabricated from the wafers. Representative detectors were tested in a low background photon flux, low temperature environment to determine the device characteristics for comparison to NASA goals for astronomical applications. The SSPM temperatures varied between 6 and 11 K with background fluxes in the range from less than 5 x 10 to the 6th power to 10 to the 13th power photons/square cm per second at wavelengths of 3.2 and 20 cm. Measured parameters included quantum efficiency, dark count rate and bias current. Temperature for optimal performance is 10 K, the highest ever obtained for SSPMs. The devices exhibit a combination of the lowest dark current and highest quantum efficiency yet achieved. Experimental data were reduced, analyzed and used to generate recommendations for future studies. The background and present status of the microscopic theory of SSPM operation were reviewed and summarized. Present emphasis is on modeling of the avalanche process which is the basis for SSPM operation. Approaches to the solution of the Boltzmann transport equation are described and the treatment of electron scattering mechanisms is presented. The microscopic single-electron transport theory is ready to be implemented for large-scale computations. Author

N89-26205# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
ROCKET-BORNE LANGMUIR PROBE RESPONSE TO AN APPLIED PERIODIC POTENTIAL
P. Muralikrishna, M. A. Abdu, and I. J. Kantor Oct. 1988 11 p Presented at the 4th Simposio Nipo Brasileiro de Ciencia e Tecnologia, 10-13 Aug. 1988
(Contract FINEP-537/CT)
(INPE-4714-PRE/1394) Avail: NTIS HC A03/MF A01

A Langmuir Probe (LP), payload designed and developed at Instituto de Pesuisas Espaciais (INPE/MCT) was flown on board a SONDA III rocket at 2259 hrs. (LST) on October 31, 1986 from the Centro de Lancamento da Barreira do Inferno in Natal, RN, Brazil, under a collaborative program between INPE and Instituto de Atividades Espaciais (IAE/CTA). The rocket reached an apogee of about 444 km and the LP payload functioned satisfactorily during the ascent as well as descent of the rocket. A sweep voltage varying between -1V and +4V in a period of about 2.6 seconds was applied to the LP sensor. As the applied voltage increased from -1V to +4V, the LP sensor current first showed an increase, reached a saturation level, and then, though the sensor potential increased towards a steady value, the current showed a systematic decrease. This sensor current characteristic also showed a clear dependence on altitude and hence on the ambient plasma parameters. Possible physical mechanisms responsible for these LP response characteristics are analyzed and discussed here. Author

N89-26206*# Old Dominion Univ., Norfolk, VA.
LOW-SPEED FLOWFIELD CHARACTERIZATION BY INFRARED MEASUREMENTS OF SURFACE TEMPERATURES Final Report, 1987 - 1989
E. Gartenberg, A. S. Roberts, Jr., and G. J. McRee May 1989 140 p
(Grant NAG1-735)
(NASA-CR-181839; NAS 1.26:181839) Avail: NTIS HC A07/MF A01 CSCL 14B

An experimental program was aimed at identifying areas in low speed aerodynamic research where infrared imaging systems can make significant contributions. Implementing a new technique, a long electrically heated wire was placed across a laminar jet. By measuring the temperature distribution along the wire with the IR imaging camera, the flow behavior was identified. Furthermore, using Nusselt number correlations, the velocity distribution could be deduced. The same approach was used to survey wakes behind cylinders in a wind-tunnel. This method is suited to investigate flows with position dependent velocities, e.g., boundary layers, confined flows, jets, wakes, and shear layers. It was found that the IR imaging camera cannot accurately track high gradient temperature fields. A correlation procedure was devised to account for this limitation. Other wind-tunnel experiments included tracking the development of the laminar boundary layer over a warmed flat plate by measuring the chordwise temperature distribution. This technique was applied also to the flow downstream from a rearward facing step. Finally, the IR imaging system was used to study boundary layer behavior over an airfoil at angles of attack from zero up to separation. The results were confirmed with tufts observable both visually and with the IR imaging camera. Author

N89-26207*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A LONG-RANGE LASER VELOCIMETER FOR THE NATIONAL FULL-SCALE AERODYNAMICS COMPLEX: NEW DEVELOPMENTS AND EXPERIMENTAL APPLICATION
Michael S. Reinath Jun. 1989 44 p Presented at the 13th International Congress on Instrumentation in Aerospace Facilities, Gottingen, Fed. Republic of Germany, 18-21 Sep. 1989
(NASA-TM-101081; A-89070; NAS 1.15:101081) Avail: NTIS HC A03/MF A01 CSCL 14B

A long-range laser velocimeter (LV) developed for remote operation from within the flow fields of the large wind tunnels of the National Full-Scale Aerodynamics Complex is described. Emphasis is placed on recent improvements in optical hardware as well as recent additions to data acquisition and processing techniques. The system has been upgraded from a dual-beam, single-color LV with focal range to 10 m, to a dual-beam, two-color LV with focal range to 20 m. At the new extended measurement range (between 10 and 20 m), signals are photon-resolved, and a photon correlation technique is applied to acquire and process the LV signals. This technique permits recovery of the velocity probability distributions at a particular measurement location from which the mean components of velocity and the corresponding normal stress components of turbulence are obtained. The method used for data reduction is outlined in detail, and a discussion of measurement accuracy is made. To study the performance of the LV and verify the measurement accuracy, laboratory measurements were made in the flow field of a 10 cm-diameter, 30-m/sec axisymmetric jet. A discussion of the requirements and techniques used to seed the flow is made, and boundary-layer surveys of mean velocity and turbulence intensity of the streamwise component and the component normal to the surface are presented. Author

N89-26208*# Aerojet TechSystems Co., Sacramento, CA.
INTEGRATED CONTROL AND HEALTH MONITORING CAPACITIVE DISPLACEMENT SENSOR DEVELOPMENT TASK. ORBIT TRANSFER ROCKET ENGINE TECHNOLOGY PROGRAM Final Report
Frank N. Collamore Jul. 1989 110 p
(Contract NAS3-23772)

(NASA-CR-182279; NAS 1.26:182279) Avail: NTIS HC A06/MF A01 CSCL 14B

The development of a miniature multifunction turbomachinery shaft displacement sensor using state-of-the-art non-contract capacitive sensing technology is described. Axial displacement, radial displacement, and speed are sensed using a single probe within the envelope normally required for a single function. A survey of displacement sensing technology is summarized including inductive, capacitive, optical and ultrasonic techniques. The design and operation of an experimental triple function sensor is described. Test results are included showing calibration tests and simultaneous dynamic testing of multiple functions. Recommendations for design changes are made to improve low temperature performance, reliability, and for design of a flight type signal conditioning unit.

Author

N89-26209*# National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, VA.

MARA (MULTIMODE AIRBORNE RADAR ALTIMETER) SYSTEM DOCUMENTATION. VOLUME 1: MARA SYSTEM REQUIREMENTS DOCUMENT

C. L. Parsons, ed. Jul. 1989 88 p

(NASA-RP-1226; Rept-89-143; NAS 1.61:1226) Avail: NTIS HC A05/MF A01 CSCL 14B

The Multimode Airborne Radar Altimeter (MARA), a flexible airborne radar remote sensing facility developed by NASA's Goddard Space Flight Center, is discussed. This volume describes the scientific justification for the development of the instrument and the translation of these scientific requirements into instrument design goals. Values for key instrument parameters are derived to accommodate these goals, and simulations and analytical models are used to estimate the developed system's performance.

Author

N89-26210# Oregon Univ., Eugene. Inst. of Theoretical Science

ULTRASMALL HOLOGRAPHIC X-RAY GRATINGS USING SYNCHUOTRON RADIATION AND X-RAY LITHOGRAPHIC TECHNIQUES Final Report, 1 May 1987 - 30 Apr. 1988

Paul L. Csonka and Roman O. Tatchyn Nov. 1988 31 p

(Grant AF-AFOSR-0211-87; AF Proj. 2301)

(AD-A206731; AFOSR-89-0415TR) Avail: NTIS HC A03/MF A01 CSCL 20/8

In a series of experiments use was made of radiation generated by the undulator magnet, recently installed on ALLADIN at the Synchrotron Radiation Center. Since the properties of that radiation were not previously known, the first step consisted of characterizing the radiation not only spectrally, but also in angular intensity space. The angular characterization was accomplished by allowing the radiation to pass through a pinhole before reaching a gold photodiode. The photodiode measurements served to ascertain the beam profiles along both the horizontal and vertical directions. In terms of the first harmonic frequency, v(1), the first harmonic photon energy, e(1), can be written as hv(1). At hv(1)=50 eV, the measurements confirmed expectations and demonstrated a Gaussian distribution along both axes. Two sets of measurement were performed: one with, the other without interposition of an aluminum filter 800 A(o) thick. GRA

N89-26211# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Electrical and Computer Engineering.

ASSOCIATIVE PROCESSORS AND DIRECTED GRAPHS FOR OPTICAL PROCESSING Final Report, Sep. 1984 - Mar. 1989

David Casasent 15 Feb. 1989 145 p

(Grant AF-AFOSR-0293-84; AF Proj. 2305)

(AD-A206739; AFOSR-89-0440TR) Avail: NTIS HC A07/MF A01 CSCL 20/5

This presents the final report on our recent 4 year effort. We briefly review our prior feature space and distortion-invariant processors. We then highlight several of our optical Artificial Intelligence processor concepts. Emphasis is given to new associative processor and directed graph optical systems for large knowledge base processing. GRA

N89-26212# Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).

MODIFICATION OF THE GERIN FALLING BALL VISCOSITY COMPARATOR MODEL V3 FOR USE AT THE STANDARD TEST TEMPERATURE OF 100 DEG C

R. D. Haggett, J. R. Matthews, and D. E. Veinot Mar. 1989 32 p

(AD-A206792; DREA-TM-89/207) Avail: NTIS HC A03/MF A01 CSCL 11/8

This report describes a modification to the Gerin Falling Ball Viscosity Comparator Model V3 for use at the standard test temperature of 100 C, which has been developed and tested at DREA Dockyard Laboratory. The Modified Falling Ball Viscosity Comparator when used at 100 C can accurately determine a percent change in the viscosity of a used MIL-L-9000G diesel lubricating oil compared to new oil of the same specification, regardless of the batch and/or manufacturer. This viscosity change can be determined onboard ship and used as a go/no-go indicator of the suitability for further service of a diesel lubricating oil. When used with fuel diluted solutions of known concentration the Modified Falling Ball Viscosity Comparator can be used to quantitatively determine the percentage fuel dilution in used diesel lubricating oil. GRA

N89-26213# Institute for Defense Analyses, Alexandria, VA.

PASSIVE RANGING Final Report, Sep. 1987 - Aug. 1988

Irwin W. Kay Aug. 1988 51 p

(Contract MDA903-84-C-0031)

(AD-A206884; AD-E501083; IDA-P-2098; IDA/HQ-88-33236)

Avail: NTIS HC A04/MF A01 CSCL 17/11

This paper compares the classical photogrammetric approach to the passive ranging problem with the approach based on the theory of optical flow applied to dynamic imagery. It also describes various errors, due to the environment and imperfections of the sensor system, long recognized by photogrammetrists but largely ignored by proponents of the optical flow methodology. An error sensitivity analysis indicates that the optical flow approach is more sensitive to errors-and to those due to image distortion, in particular-than is the photogrammetric approach. This is primarily because of the necessarily small line-of-sight angle between two views of the same object point by the sensor, especially when the sensor platform is constrained to move nearly parallel to the optical axis of the system. Although this constraint on the platform motion guarantees that the focus of expansion (FOE) remains in the field of view, that fact does not make the system less sensitive to error, but rather more so. Analysis shows that the opposite constraint imposed by photogrammetrists, having the platform move in a direction orthogonal to the optical axis, reduces the error sensitivity even though it forces the FOE out of the field of view-in fact, to infinity. GRA

N89-26214# Washington Univ., Seattle. Geophysics Program.

SPACE SCIENCE INSTRUMENTATION Final Report, 1 Oct. 1986 - 30 Sep. 1988

R. H. Holzworth 15 Mar. 1989 4 p

(Contract N00014-87-J-1045)

(AD-A207043) Avail: NTIS HC A02/MF A01 CSCL 14/2

This grant was intended to be used for the purchase of high quality laboratory and data analysis instrumentation for the pursuit of space plasma physics research. Two of the first purchases were a 6250 BPI magnetic tape drive and a large, fast disk drive. These improved the satellite data analysis capability greatly and reduced the system backup time. With the big disk drive it became possible to dump entire magnetic tapes to disk for faster, more efficient processing. Several microcomputers improve both personnel computing as well as general connectivity within the group and on campus in general. Other microcomputers function in the laboratory setting by acting as hosts for several instrument interfaces for communication with satellite and balloon payloads as well as laboratory VLF signal processing equipment. Perhaps the single most expensive item purchased was an analog tape drive for reading and writing 16 in. analog magnetic tapes. This

analog tape drive is used for the direct processing of FM and directly recorded telemetry data from the balloon and rocket payloads. GRA

N89-26215# Nevada Univ. System, Reno. Atmospheric Sciences Center.
DETECTION OF ORGANOPHOSPHORUS AEROSOLS BY A CLOUD CONDENSATION NUCLEI SPECTROMETER OF NEW DESIGN Technical Report, Apr. 1986 - Dec. 1987
James G. Hudson, Ya Y. Dong, John Hallet, Hugh R. Carlon, and Craig R. Allan (Chemical Research and Development Center, Aberdeen Proving Ground, MD.) Mar. 1989 40 p
(Contract DAAA15-86-C-0020; DA Proj. 1C1-62706-A-553)
(AD-A207144; CRDEC-TR-043) Avail: NTIS HC A03/MF A01 CSCL 04/1

The Cloud Condensation Nuclei (CCN) Spectrometer is a newly-developed instrument, which was devised and built by the Desert Research Institute (DRI). Unlike other CCN Spectrometers, this one uses droplet size to infer the critical supersaturation (Sc) spectrum of the sampled aerosol. The new instrument obtains simultaneous CCN spectra from the droplet spectra. Since the nuclei can be as small as 0.01 micrometer in diameter and are too small to obtain a size spectrum, they are amplified by water condensation to micrometer sizes that can be easily detected by an optical particle counter. The droplet spectrum is then related to the CCN spectrum through calibration using monodisperse salt aerosol with known Sc's. Droplet size dispersion is achieved by exposing the sample to an increasing Sc as it passes through the chamber. Preliminary studies have shown that the new system can detect and characterize organophosphorus aerosols, such as Malathian, and is useful in measuring and identifying natural or background aerosols against which chemical warfare aerosols would have to be detected. Further work is suggested to improve detection specificity and to permit a wider range of water-insoluble substances to be detected. GRA

N89-26216# Technische Univ., Delft (Netherlands).
A NEW GAMMA CAMERA FOR POSITRON EMISSION TOMOGRAPHY Ph.D. Thesis
Paul Schotanus 1988 207 p
(ETN-89-94888) Avail: NTIS HC A10/MF A01

The detection of annihilation radiation employing radiation absorbed in a barium fluoride (BaF2) crystal is described. The resulting scintillation light is detected in a multiwire proportional chamber filled with a photosensitive vapor. The use of a high density fast scintillator with a low pressure wire chamber offers a good detection efficiency and permits high count rates because of the small dead time. The physical background of the detection mechanism is explored and the performance parameters of a gamma camera using this principle are determined. The scintillation mechanism and physical characteristics of the BaF2 scintillator are examined. Ultraviolet scintillation materials consisting of rare earth doped fluorides are introduced. ESA

N89-26217 Politecnico di Milano (Italy). Laboratori di Calcolatori.
A FAULT TOLERANT ORIENTED CMOS SYSTOLIC IMPLEMENTATION OF A FIR FILTER
G. L. Aranci, C. A. Binda, U. Clerici, and E. Comignaghi 1988 13 p
(Rept-88-027; ETN-89-94971) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

The implementation of a FIR digital filter chip based on a systolic array is described. Using the intrinsic regularity of such linear array, the filter can be made fault tolerant with limited additional hardware. ESA

N89-26218*# Sverdrup Technology, Inc., Cleveland, OH.
TWO-DIMENSIONAL HIGH TEMPERATURE OPTICAL STRAIN MEASUREMENT SYSTEM, PHASE 2 Final Report
Christian T. Lant Jul. 1989 22 p
(Contract NAS3-25266)
(NASA-CR-185116; E-4923; NAS 1.26:185116) Avail: NTIS HC A03/MF A01 CSCL 14B

A laser speckle strain measurement system with two-dimensional measurement capabilities has been built and tested for high temperature applications. The 1st and 2nd principle strains at a point on a specimen are calculated from three components of one-dimensional strain. Strain components are detected by cross-correlating reference and shifted speckle patterns recorded before and after straining the specimen. Speckle patterns are recorded by a linear photodiode array camera. Accurate strains have been measured at temperatures up to 650 C. Stable speckle correlations and linear stress-strain relations have been demonstrated up to 750 C. The resolution of the system is 15 microstrains, with a gauge length less than 1 mm. Author

36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

N89-26219 Department of the Air Force, Washington, DC.
PREMIXED COLD REACTION CW LASER NOZZLE Patent
Dale L. Hook, inventor (to Air Force) and James E. Broadwell, inventor (to Air Force) 15 Nov. 1988 7 p
(AD-D013984; US-Patent-4,785,461; US-Patent-Appl-SN-011084; US-Patent-Class-372-89) Avail: US Patent and Trademark Office CSCL 09/3

The premixed cold reaction continuous wave (CW) chemical laser places the secondary injectors which input fuel and/or diluent in the exit walls of the primary nozzle. These injectors are acutely angled and are arranged in rows and are further grouped therein where a first injector inputs a pure diluent, and a second group of injectors inputs independently of a third group. GRA

N89-26220*# Old Dominion Univ., Norfolk, VA. Dept. of Mathematical Sciences.
COMPARISON OF LASER MODELS Progress Report, period ended 15 May 1989
John H. Heinbockel Jun. 1989 14 p
(Grant NAG1-757)
(NASA-CR-185390; NAS 1.26:185390) Avail: NTIS HC A03/MF A01 CSCL 20E

Progress on the comparison of laser models is reported. Equations for an oscillatory model and a nonoscillatory model for the simulation of iodine laser operation are solved. Reaction rate coefficients used in both models are listed. Currently there are four models for the simulation of iodine laser operation are solved. Reaction rate coefficients used in both models are listed. Currently there are four models for the simulation of an iodine laser. They are: (1) a time dependent model; (2) a quasi-steady state model; (3) a noncompressible model; and (4) a compressible flow laser model. Current research is being directed toward: (1) parameter studies using the compressible flow laser model; (2) development of a two-pass amplifier model; and (3) solving a system of equations describing operation of the high powered iodine MOPA (master oscillator power amplifier). K.C.D.

N89-26221*# Kanner (Leo) Associates, Redwood City, CA.
LASER ANEMOMETRY FOR HOT FLOWS
P. Kugler and G. Langer Jul. 1987 21 p Original language document was announced in IAA as A87-27213
(NASA-TT-20077; NAS 1.77:20077) Avail: NTIS HC A03/MF A01 CSCL 20E

The fundamental principles, instrumentation, and practical operation of LDA and laser-transit-anemometry systems for measuring velocity profiles and the degree of turbulence in high-temperature flows are reviewed and illustrated with diagrams, drawings and graphs of typical data. Consideration is given to counter, tracker, spectrum-analyzer and correlation methods of LDA signal processing; multichannel analyzer and cross correlation methods for LTA data; LTA results for a small liquid fuel rocket

motor; and experiments demonstrating the feasibility of an optoacoustic demodulation scheme for LDA signals from unsteady flows. Author

N89-26222# Haas-Laser G.m.b.H., Schramberg (Germany, F.R.).
TESTS FOR POWER SUPPLY UNITS AND BEAM SOURCES OF SOLID-STATE LASERS IN THE SCOPE OF THE EUROLASER DEFINITION PHASE Final Report, Oct. 1987
Reinhard Ifflaender Oct. 1987 20 p In GERMAN; ENGLISH summary
(Contract BMFT-13-EU-0028/3)
(ETN-89-94627) Avail: NTIS HC A03/MF A01

The Eurolaser project and research for solid-state laser power supply are discussed. The power supply unit includes excitation by conventional lamps, bipolar electrodes, or HF discharges. Performance of each type is analyzed and test results of multicavity resonators are given. ESA

N89-26223# SRI International Corp., Menlo Park, CA.
CHARACTERIZATION OF CHEMICAL SOURCES OF N2(A3 SIGMA U +) Final Report, Sep. 1984 - Sep. 1988
Graham Black Feb. 1989 80 p
(Contract F29601-84-C-0099; AF Proj. 3326)
(AD-A206604; SRI-MP-88-214; AFWL-TR-88-114) Avail: NTIS HC A05/MF A01 CSCL 07/2

The C2N2-O2 system has been examined as a source of N(D-2) and N2(A3 sigma u +) with application to an energy transfer chemical laser. Both flowing afterglow and pulsed photodissociation techniques have been used to generate the CN radicals that initiate the chemical generation steps. Laser-induced fluorescence techniques have been used to monitor CN, NCO, and N2(A3 sigma u +). The resonance-enhanced multiphoton ionization (REMPI) technique was developed for N(D-2). During this work, vibrationally excited nitrogen was also characterized by its REMPI signals, and two-photon dissociation of both NO and N2O were discovered as sources of N(D-2). The REMPI technique was then applied to the C2N2-O2 system, in which the presence of N(D-2) was demonstrated and its temporal profile measured. GRA

N89-26224# Lockheed Missiles and Space Co., Palo Alto, CA. Research and Development Div.
SEMICONDUCTOR SURFACE EMITTING LASER DIODES Final Draft Report
S. C. Wang and T. G. Dziura 30 Mar. 1989 128 p
(Contract N00014-87-C-0492)
(AD-A206626) Avail: NTIS HC A07/MF A01 CSCL 09/3

The conventional edge emitting laser diode uses either a single-stripe or multiple structure consisting of an active layer in a plane parallel to the semiconductor surface; two cleaved facets, functioning as laser cavity mirrors are perpendicular to this active layer. It is relatively difficult to fabricate and diagnose in situ, and only one-dimensional laser arrays have been monolithically fabricated. The surface emitting laser (SEL), on the other hand, utilizes both surfaces of the wafer as laser mirrors and the light output is perpendicular to the wafer plane. This makes planar fabrication and diagnosis easier, and more importantly, allows for two-dimensional (2-D) monolithic integration and array formation. This 2-D SEL array can be in scale in number and size while maintaining a high filling factor. The SEL array diodes can also be individually addressed and controlled, as well as the output beam. The output beam can also be easily accessed from both the front and back surfaces of the wafer. These features are very important and desirable when a large array of coherent emission semiconductor lasers is needed. GRA

N89-26225# SRI International Corp., Menlo Park, CA.
DIAGNOSTICS DEVELOPMENT FOR E-BEAM EXCITED AIR CHANNELS Technical Report, No. 4
K. R. Stalder, M. S. Williams, and D. J. Eckstrom Feb. 1989 65 p
(Contract N60921-85-C-0210; ARPA Order 4395)
(AD-A206678; SRI-MP-88-292) Avail: NTIS HC A04/MF A01 CSCL 07/4

The conductivity of reduced density channels made by laser-initiated and exploding-wire-initiated discharges was measured systematically by microwave interferometry. The results show that the DC conductivity can be as high as 5 x 10(10)/s for the laser channels and as high as 10(11)/s for the exploding wire channels. The channel temperature inferred from the conductivity levels is as high as 4000 K. The channels cool by adiabatic expansion, and subsequent turbulent convective mixing of the hot central plasma with the cold surrounding air; as a result, the conductivity drops to 5 x 10 (9)s in 2-6 ms, depending on the initial discharge energy. The effects of impurities are discussed, as are the implications for charged particle beam propagation in such channels. GRA

N89-26226# United Technologies Research Center, East Hartford, CT.
INVESTIGATION OF PLASMA PROCESSES IN ELECTRONIC TRANSITION LASERS Final Report, 1 Jan. 1985 - 31 Dec. 1988
William L. Nighan 28 Feb. 1989 97 p
(Contract N00014-85-C-0259; DA Proj. RR0-1107)
(AD-A206713; UTRC/R89-927162-1) Avail: NTIS HC A05/MF A01 CSCL 09/3

United Technologies Center has conducted an investigation of the fundamental processes affecting the operation, performance and application of electrically excited lasers having potential utility in a variety of areas of importance to the Navy. Particular attention was focused on the broadband XeF(C to A) laser, which has the potential for efficient, tunable operation throughout the blue-green spectral region. The research at UTRC was coordinated with a complementary ONR-supported experimental program conducted at Rice University. The results of this investigation are summarized and reprints included for published papers in which specific results and conclusions of the research are described in detail. GRA

N89-26227# Illinois Univ., Urbana. Dept. of Electrical and Computer Engineering.
NON-LINEAR OPTICAL TECHNIQUES FOR THIN FILM GROWTH AND VISIBLE ULTRAVIOLET LASERS Final Report, 30 Sep. 1985 - 29 Sep. 1988
J. G. Eden 30 Nov. 1988 49 p
(Contract F49620-85-C-0141)
(AD-A206811; AFOSR-89-0437TR) Avail: NTIS HC A03/MF A01 CSCL 09/1

The goals of this AFOSR-supported program were: (1) to investigate novel applications of non-linear gas phase photochemistry to the low temperature growth of semiconductor and metal films, and (2) to develop new sources of stimulated emission at short wavelengths (lambda is less than 200 nm). This work has resulted in several significant accomplishments: epitaxial semiconductor (Ge) films were grown on GaAs at temperatures as low as 285 C by laser photochemical vapor deposition (LPVD); NH3 was demonstrated as a photosensitizer in the LPVD growth of films; Ge/Si alloys were grown by LPVD and analyzed; the photochemical nature of laser assisted MOCVD growth of GaAs on GaAs was demonstrated; and the excited state structure of Zn2, Cd2, Ar2, and Ne2 was examined by laser spectroscopy. GRA

N89-26228# Israel Academy of Sciences and Humanities, Jerusalem.
PROGRAM AND ABSTRACTS OF THE INTERNATIONAL FREE ELECTRON LASER CONFERENCE (10TH) HELD IN JERUSALEM, ISRAEL ON AUGUST 29-SEPTEMBER 2, 1988
2 Sep. 1988 138 p Conference held in Jerusalem, Israel, 29 Aug. - 2 Sep. 1988
(Contract N00014-88-J-1092)
(AD-A207016) Avail: NTIS HC A07/MF A01 CSCL 09/3

The proceedings of the conference are presented in abstract form. Experiments, status of experiments, applications, future

experiments, and technology, wigglers, and unconventional schemes were session area topics. E.R.

N89-26229# Florida Univ., Gainesville. Space Astronomy Lab.
THE INTERACTION OF SOLID PARTICLES WITH LASER BEAMS Final Report
Nebil Y. Misconi, Edwin T. Rusk, and John P. Oliver 8 Apr. 1989 108 p
(Contract F49620-85-C-0117)
(AD-A207055; AFOSR-89-0475TR) Avail: NTIS HC A06/MF A01 CSCL 20/6

Light scattering curves of intensity vs. scattering angle were made of layers of transparent silica particles, single silica particles isolated by optical levitation; using an Argon ion laser light source and a goniometer mounted silicon photodiode detector. Scattering measurements of spherical particles demonstrated an excellent agreement with Mie theory. Spheroids and irregular particles were also measured. Dynamics of particles in a space environment were studied both theoretically, and experimentally inside a 10 to the -7th power Torr vacuum chamber. Research in this area will be continued to determine the effective moment arm of optically induced particle rotation. GRA

N89-26230# Missouri Univ., Saint Louis. Dept. of Physics.
CHAOTIC AND BIFURCATING NONLINEAR SYSTEMS DRIVEN BY NOISE WITH APPLICATIONS TO LASER DYNAMICS Annual Report, 1 Dec. 1987 - 31 Oct. 1988
Frank Moss 30 Dec. 1988 85 p
(Contract N00014-88-K-0084)
(AD-A207132) Avail: NTIS HC A05/MF A01 CSCL 09/3

The objective of this grant is to pursue research in the field of noise driven nonlinear laser dynamical systems by means of both analog and digital simulations. The first, is an electronic circuit modelling of the effects of purely multiplicative noise on the correlated spontaneous emission laser. The second, is a modelling of the general problem of stochastic resonance, and a study of the effects of the modulation and noise as they relate to the recently observed phenomenon in a dye ring laser. Four projects have been completed: The first is a generalization of mean-first-passage time calculations to problems involving spatio-temporal noise. Specifically considered is a Brownian particle moving in a random spatial potential driven by temporal noise. Second, an experiment and a contemporary theory completed on generalized switching processes in the presence of colored noise. Third, a discovery was made using analog techniques with strongly colored noise: a noise correlation time induced change in the topology of the two dimensional probability density of multistable systems. Fourth, an interesting example problem was given on state dependent diffusion posed by Landauer and Van Kampen. GRA

N89-26231# Office of Naval Research, Arlington, VA.
QUASI-AROMATIC HETEROCYCLICS AS LASER DYES Interim Technical Report
Theodore G. Pavlopoulos and Joseph H. Boyer 19 Apr. 1989 10 p
(AD-A207134; ONR-TR-12) Avail: NTIS HC A02/MF A01 CSCL 07/3

Superior laser dyes were recently discovered in the quasi-aromatic families of syn-dioxabimanes and pyrromethene-BF2 complexes. The representative new dye mu-bis-(carboethoxy) methylene syn-(methylene, methyl) bimane lased at 507 nm with 50 percent greater efficiency than was obtained with Coumarin 30. A similar determination showed 4, 4-difluoro 1,3,5,7,8-pentamethyl 4-bora 3a,4a-diaza-s-indacene to lase at 546 nm with about 300 percent greater efficiency than was obtained from Coumarin 545. These quasi-aromatic systems are readily available and offer desirable properties of stability (photo, thermal, and chemical), solubility, and diminished triplet-triplet absorption in the lasing spectral region. Selected spectroscopic and lasing properties of these new laser dyes are presented. GRA

N89-26232# Office of Naval Research, Arlington, VA.
TRIPLET EXTINCTION COEFFICIENTS OF SOME LASER DYES 2 Interim Technical Report
Theodore G. Pavlopoulos and Daniel J. Golich 19 Apr. 1989 21 p
(AD-A207135; ONR-TR-13) Avail: NTIS HC A03/MF A01 CSCL 07/3

We measured the triplet extinction coefficients T over the laser action spectral region of DODC, DMC, Sulforhodamine B, Rhodamine 575, Coumarin 523, Coumarine 521 Coumarin 504, Coumarin 498, Coumarin 490, LD466, bis-MSB, BBO, and OLIG0415. We employed the different lines from an argon and a krypton ion cw laser for excitation. McClure's method was again employed to measure the triplet extinction coefficients. We provide a simplified derivation of McClure's equation. The triplet extinction coefficient of Rhodamine 575 was also measured by using the depletion method and improving it by reconstructing for true triplet-triplet absorption. The value obtained is in good agreement with the one obtained by McClure's method. GRA

N89-26233 Department of the Air Force, Washington, DC.
DIELECTRIC RIDGE WAVEGUIDE GAS LASER APPARATUS Patent
Anthony J. DeMaria, inventor (to AF) and William Bridges, inventor (to AF) 14 Mar. 1989 9 p Filed 23 Dec. 1987 Supersedes AD-D013642
(AD-D014104; US-Patent-4,813,052; US-Patent-Appl-SN-137541; US-Patent-Class-372-64) Avail: US Patent and Trademark Office CSCL 09/3

This patent relates to waveguide gas laser having a ridged dielectric substrate to form a gas filled region in which an electric discharge generates a lasing mode. These ridged waveguide configurations may be utilized in either a rectangular or circular guide structure. In the first embodiment, a rectangular waveguide has a plurality of periodically spaced metal electrodes on its upper and lower exterior surfaces. The upper and lower interior surfaces of the rectangular waveguide comprises a dielectric having a plurality of 60 ridges which extend along the longitudinal axis of the waveguide. The plurality of ridges are special periodically and are in alignment with the exterior electrode stripe. In a second embodiment of the invention, the longitudinal ridges are formed around the interior peripheral surface of the tubular waveguide. Both embodiments are designed to permit an optical mode to exit within the ridges. Thus, the apparatus can be used to couple the evanescent component of the optical mode to an adjacent optical mode in an adjacent ridge guide. This coupling will provide a phase locking mechanism for adjacent waveguide lasers which in turn may have high power applications. GRA

N89-26234# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
FABRICATION AND CHARACTERIZATION OF Pb(1-x)Sn(x)Te SEMICONDUCTOR LASERS UTILIZING THE LIQUID PHASE EPITAXY (LPE) TECHNIQUE M.S. Thesis [FABRICACAO E CARACTERIZACAO DE LASERS SEMICONDUTORS DE PB1-XSNXTE UTILIZANDO A TECNICA DE EPITAXIA A PARTIR DA FASE LIQUIDA-LPE]
Eduardo Abramof Aug. 1988 105 p In PORTUGUESE; ENGLISH summary
(INPE-4685-TDT/341) Avail: NTIS HC A06/MF A01

All steps in the lasers fabrication are described, from the single crystal growth to the characterization of the device. The LPE technique is applied to the formation of the p-n junction. PbTe lasers are fabricated with the following structures: p+-n and p+-n-n+. The device charcterization at 80 K includes: ixV curve, I sub Lxi curve and spectral emission. The threshold current density of the lasers is in the range of 2.5 KA/sq cm and the peak emission in 5.8 microns. Many problems in the fabrication process and in the mounting package of the laser lead to degradation of the device after a time of usage. Author

N89-26235# Zeiss (Carl), Oberkochen (Germany, F.R.).
EUREKA DEFINITION PHASE, SOLID STATE LASER. RESONATOR CALCULATIONS AND BEAM HANDLING Final Report
Peter Greve, Herbert Gross, Gerhard Hohberg, and Harald Sakowski Jul. 1987 97 p In GERMAN; ENGLISH summary
(Contract BMFT-FB-13-EU-017)
(ETN-89-94987) Avail: NTIS HC A05/MF A01

Solid state laser optimization is performed by analysis of geometry and the influence of the pump cavity on the pump light distribution within the laser crystal. Ideally the pump light distribution is taken into account when calculating the resonator. A ray-tracing program is developed for the pump cavity. Theoretical and experimental results are compared for a double-elliptical cavity. The beam handling of solid state lasers can be done with fiber optics or articulated arms. Advantages and disadvantages of these methods are compared. ESA

37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

N89-26236# National Aerospace Lab., Tokyo (Japan).
PERFORMANCE OF SMALL HIGH SPEED ROCKET PUMPS
Yoshiaki Watanabe, Mitsuo Watanabe, and Kenjiro Kamijo Mar. 1988 13 p In JAPANESE; ENGLISH summary
(NAL-TR-963; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

For more than ten years, several small cryogenic pumps for liquid rocket engines have been made for purposes of research and development by the National Aerospace Laboratory and the National Space Development Agency of Japan. These pumps were made for use with liquid oxygen (LOX) and liquid hydrogen (LH2) feed pumps. They have very small impellers and are characterized by high speed and high head. The main design characteristics of these pumps are as follows: stage specific speeds of from 0.0319 to 0.0766, flow rates from 0.016 to 0.0525 m to the 3rd power/s, pressure rises from 4.9 to 26 MPa, rotational speeds from 16,500 to 80,000 rpm and impeller diameters from 0.083 to 0.146 m. These pumps were tested using water, LOX, liquid nitrogen (LN2) and liquid hydrogen as the pump fluids. Not only are overall performance factors such as efficiency and head/flow characteristics studied but also suction performance of these pumps. Author

N89-26237 Oregon Univ., Portland.
A MODEL REFERENCE ADAPTIVE SYSTEM FOR CONTROL OF A FLEXIBLE MECHANICAL MANIPULATOR Ph.D. Thesis
Byeung Kyun Lee 1988 173 p
Avail: Univ. Microfilms Order No. DA8901208

For control of a flexible manipulator, the assumed-mode method is applied to the mathematical model of the model reference adaptive system. In the assumed-mode method, the flexible, continuous manipulator is described by a limited number of degrees of freedom. A modified model reference adaptive system is studied for direct application of the adaptive control scheme to the control of a flexible manipulator. Use of the assumed-mode method and the modified model reference adaptive system reduce difficulties in designing the controller of the flexible manipulator. A numerical simulation, using the above procedure, is developed to identify a flexible manipulator with unknown parameters and simulation results show the satisfactory convergence of the parameters. Author

N89-26238 Oregon Univ., Portland.
DERIVATION AND AUTOMATIC GENERATION OF KANE'S DYNAMICAL EQUATIONS FOR MECHANICAL MANIPULATORS Ph.D. Thesis
Tinglin Nie 1988 156 p
Avail: Univ. Microfilms Order No. DA8900170

To design and precisely control a manipulator requires developing an efficient dynamic model of the system. The present work demonstrates how this can be accomplished by employing Kane's dynamical equations. First, a detailed manual derivation of the equations of motion for a particular robot is presented in such way that each step in the analysis serves as an example for the derivation of the dynamic equations for serial manipulators in general. Discussions are given regarding the merits of using different sets of generalized speeds. Based on this formulation procedure, an algorithm is presented, which enables computers to automatically generate and integrate Kane's dynamical equations of motion for mechanical manipulators, or to calculate the torques and/or forces required to carry out a user-specified motion of the manipulator. Applicable to nearly any manipulator, the algorithm uses recursive computations of angular velocities, velocities, generalized inertia forces and generalized active forces. To save computation time, all ingredients for formulating the equations of motion are expressed in scalar forms. The resulting equations contain no approximations beyond the assumptions that the links are rigid and perfectly connected. As an example, simulation results of both manually-derived and automatically-generated equations for the Intelledex 605 Robot arm are reported and it is shown that the algorithm is more efficient than those in the listed literature. Dissert. Abstr.

N89-26239 Bath Univ. (England).
FRACTURE AND AGEING OF ELASTOMERIC O-RING SEALS Ph.D. Thesis
C. A. Stevens 1988 366 p
Avail: Univ. Microfilms Order No. BRDX83771

The possible fracture of elastomeric O-ring seals in both normal and postulated fault conditions pertaining to the electricity generating industry were investigated. The review of the fracture mechanics of elastomers established that fracture will occur when the driving force for fracture, the tearing energy, exceeds the threshold value. The rate of crack propagation, in turn, will be governed by the fracture resistance: the critical tearing energy. Three fluorocarbon elastomers were characterized for the variations of critical tearing energy with both temperature and crack growth rate. From these results, extrapolated values were obtained for the threshold tearing energies. The driving force for fracture for the compressed O-ring geometry was calculated using a finite element computer program (FEMALES). A J-integral method was adopted, and the results amended to incorporate both the effects of large stresses at large strains, and the initiation of fracture at the boundary of an inherent flaw. The computed results were observed to agree with experimental times for O-ring fracture. Critical design relationships between O-ring cord diameter, seal compression and the stiffness of the material were calculated from the results. The performance of seals under central electricity generating board (CEGB) normal operating conditions of a few years at moderately elevated temperature were investigated by accelerated thermal ageing of relaxed and strained specimens. The postulated fault conditions of a thermal transient were predicted to neither cause fracture nor chemical degradation. Dissert. Abstr.

N89-26240 Department of the Air Force, Washington, DC.
SUPERCONDUCTING ROTOR COOLING SYSTEM Patent
Phillip W. Eckels, inventor (to Air Force) 18 Oct. 1988 4 p Filed 13 Oct. 1987
(AD-D014020; US-Patent-4,779,017; US-Patent-Appl-SN-107197; US-Patent-Class-310-52) Avail: US Patent and Trademark Office
CSCL 13/1

A superconducting rotor cooling system for an electrical generator includes a free vortex type pump which is located within and forms an integral part of the rotor assembly. The free vortex pump takes advantage of the centrifugal force of rotation of the cooling fluid to help the rotor winding compartment to remain in a superfluid helium state. Improved cooling results from combined natural convection (which occurs in a conventional rotor) and the superfluid heat transport (which occurs at the velocity of sound). GRA

N89-26241# Environmental Protection Agency, Ann Arbor, MI. Office of Mobile Sources.
EVALUATION OF A RESISTIVELY HEATED METAL MONOLITH CATALYTIC CONVERTER ON A GASOLINE-FUELED VEHICLE
Gregory K. Piotrowski Dec. 1988 30 p
(PB89-159818; EPA/AA/CTAB/89-12) Avail: NTIS HC A03/MF A01 CSCL 13I

The major portion of hydrocarbon and carbon monoxide emissions measured from a catalyst-equipped gasoline vehicle over the Federal Test Procedure (FTP) cycle are generated during the cold start and warmup of the catalyst. These emissions are difficult to control because engine-out emissions are high and catalytic converters have low conversion efficiency during their warm-up phase of operation. A resistively heated metal monolith catalyst was evaluated by EPA Motor Vehicle Emission Laboratory on a methanol-fueled vehicle. Results from this previous testing indicated the feasibility of the concept of a resistively heated metal monolith substrate as a quick light-off catalyst support. The evaluation of such a catalyst on a gasline-fueled vehicle is described. The vehicle was tested at 72 to 74 F ambient test cell conditions and at 20 deg ambient cold-room conditions. GRA

N89-26242# Department of the Army, Washington, DC.
BEVEL GEAR BACKLASH AND CLUTCH DEVICE Patent Application
Roger R. Smith, inventor (to Army) 20 Mar. 1989 9 p Filed 20 Mar. 1989
(AD-D014085; US-Patent-Appl-SN-326778) Avail: NTIS HC A02/MF A01 CSCL 13/9

An antibacklash beveled gear drive is disclosed. The drive is constructed to adjust for initial misalignment and subsequent wear. One of the gears is journaled on a driven shaft and has a biasing means which bump the gears into engagement. GRA

N89-26243# Oxford Univ. (England). Dept. of Engineering Science.
THE EFFECT OF LOAD ON THE TOOTH MESHING VIBRATION OF A SPIRAL BEVEL GEAR WITH A SMALL FATIGUE CRACK
P. D. McFadden 1989 35 p
(OUEL-1751/89; ETN-89-94820) Avail: NTIS HC A03/MF A01

Three digital signal processing techniques are applied to the time domain averages to extract the small changes in the vibration which are caused by the fatigue crack. The performance of each technique is examined as a function of the load on the gear. Estimates of the location of the fatigue crack produced from the results of one of the enhancement techniques are in good agreement with the actual location. ESA

N89-26244# Technische Univ., Eindhoven (Netherlands).
ON FRICTION IN FORMING: AN EXPERIMENTAL-NUMERICAL METHOD TO QUANTIFY CONTACT BEHAVIOR Ph.D. Thesis
Franciscus Jozef Mar Starmans 1989 152 p
(ISBN-90-9002-611-8; ETN-89-94880) Avail: NTIS HC A08/MF A01

Phenomelological models for mechanical interactions: the friction model of Coulomb, the Von Mises model, and elastoplastic analogies were studied. A thermodynamical continuum framework for the contact behavior in forming processes is presented. The mechanical contact models fit within this framework under quite general conditions. It is shown that measurement of the normal stress and, if possible, the shear stress in the contact area between tool and workpiece is necessary to obtain reliable values for contact quantities suitable to evaluate the contact behavior. The accuracy of the contact quantities can be increased by also taking the displacements of the unloaded surface into account, provided these are measured accurately enough. A contactless photogrammetric displacement measuring method is presented. The theoretically predicted accuracy is not reached, due to deficiencies in the modelling. A contact stress measuring tool for upsetting experiments was developed. Measurement of the elastic strains within the tool combined with a numerical model, delivers the values of the contact stresses between tool and workpiece. The strains are measured with thin film strain transducers. ESA

N89-26245*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTICAL PROPERTIES OF SPUTTERED ALUMINUM ON GRAPHITE/EPOXY COMPOSITE MATERIAL
William G. Witte, Jr. and Louis A. Teichman Aug. 1989 25 p
(NASA-TM-101620; NAS 1.15:101620) Avail: NTIS HC A03/MF A01 CSCL 13I

Solar absorptance, emittance, and coating thickness were measured for a range of coating thicknesses from about 400 A to 2500 A. The coatings were sputtered from an aluminum target onto 1-inch-diameter substrates of T300/5209 graphite/epoxy composite material with two different surface textures. Solar absorptance and emittance values for the specimens with the smooth surface finish were lower than those for the specimens with the rough surface finish. The ratio of solar absorptance to emittance was higher for the smooth specimens, increasing from 2 to 4 over the coating thickness range, than for the rough ones, which had a constant ratio of about 1. The solar absorptance and emittance values were dependent on the thickness of the sputtered coating. Author

N89-26246*# Detroit Diesel Allison, Indianapolis, IN. Gas Turbine Div.
AGT (ADVANCED GAS TURBINE) TECHNOLOGY PROJECT Final Report
Aug. 1988 203 p
(Contract DEN3-168)
(NASA-CR-182127; DOE/NASA/0168-11; EDR-13295; NAS 1.26:182127) Avail: NTIS HC A10/MF A01 CSCL 20E

An overall summary documentation is provided for the Advanced Gas Turbine Technology Project conducted by the Allison Gas Turbine Division of General Motors. This advanced, high risk work was initiated in October 1979 under charter from the U.S. Congress to promote an engine for transportation that would provide an alternate to reciprocating spark ignition (SI) engines for the U.S. automotive industry and simultaneously establish the feasibility of advanced ceramic materials for hot section components to be used in an automotive gas turbine. As this program evolved, dictates of available funding, Government charter, and technical developments caused program emphases to focus on the development and demonstration of the ceramic turbine hot section and away from the development of engine and powertrain technologies and subsequent vehicular demonstrations. Program technical performance concluded in June 1987. The AGT 100 program successfully achieved project objectives with significant technology advances. Specific AGT 100 program achievements are: (1) Ceramic component feasibility for use in gas turbine engines has been demonstrated; (2) A new, 100 hp engine was designed, fabricated, and tested for 572 hour at operating temperatures to 2200 F, uncooled; (3) Statistical design methodology has been applied and correlated to experimental data acquired from over 5500 hour of rig and engine testing; (4) Ceramic component processing capability has progressed from a rudimentary level able to fabricate simple parts to a sophisticated level able to provide complex geometries such as rotors and scrolls; (5) Required improvements for monolithic and composite ceramic gas turbine components to meet automotive reliability, performance, and cost goals have been identified; (6) The combustor design demonstrated lower emissions than 1986 Federal Standards on methanol, JP-5, and diesel fuel. Thus, the potential for meeting emission standards and multifuel capability has been initiated; (7) Small turbine engine aerodynamic and mechanical design capability has been initiated; and (8) An infrastructure of manpower, facilities, materials, and fabrication capabilities has been established which is available for continued development of ceramic component technology in gas turbine and other heat engines. Author

N89-26456*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE TELEROBOTIC SYSTEMS: APPLICATIONS AND CONCEPTS
L. Jenkins *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 29-34 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26457*# Boeing Aerospace Co., Huntsville, AL.
LABORATORY TESTING OF CANDIDATE ROBOTIC APPLICATIONS FOR SPACE
R. B. Purves *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 35-44 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26464*# California Univ., Santa Barbara.
ROBOT DESIGN FOR A VACUUM ENVIRONMENT
S. Belinski, W. Trento, R. Imani-Shikhabadi, and S. Hackwood *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 95-103 Sponsored in part by Delco Systems Operations (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26465*# Ohio State Univ., Columbus.
MULTI-LIMBED LOCOMOTION SYSTEMS FOR SPACE CONSTRUCTION AND MAINTENANCE
K. J. Waldron and C. A. Klein *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 105-111 (For primary document see N89-26454 20-63)
(Contract NAG1-30; DAAE07-84-K-R001)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26478*# TeleRobotics International, Inc., Knoxville, TN.
DISTRIBUTED CONTROL ARCHITECTURE FOR REAL-TIME TELEROBOTIC OPERATION
H. L. Martin, P. E. Satterlee, Jr., and R. F. Spille *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 223-231 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26479*# Grumman Aerospace Corp., Bethpage, NY.
HIGH PERFORMANCE ARCHITECTURE FOR ROBOT CONTROL
E. Byler and J. Peterson (Grumann Data Systems Corp., Woodbury, NY.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 233-239 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26482*# Oak Ridge National Lab., TN.
THE 3-D WORLD MODELING WITH UPDATING CAPABILITY BASED ON COMBINATORIAL GEOMETRY
M. Goldstein, F. G. Pin, G. deSaussure, and C. R. Weisbin *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 273-282 Previously announced as N87-20643 Sponsored in part by Nuclear Research Centre, Negev, Israel (For primary document see N89-26454 20-63)
(Contract DE-AC05-84OR-21400)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26486*# Carnegie-Mellon Univ., Pittsburgh, PA.
CERTAINTY GRIDS FOR MOBILE ROBOTS
H. P. Moravec *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 307-312 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26487*# Advanced Decision Systems, Mountain View, CA.
ENVIRONMENTAL MODELING AND RECOGNITION FOR AN AUTONOMOUS LAND VEHICLE
D. T. Lawton, T. S. Levitt, C. C. McConnell, and P. C. Nelson *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 313-336 (For primary document see N89-26454 20-63)
(Contract DACA78-85-C-0005)
Avail: NTIS HC A16/MF A01 CSCL 13I

N89-26493*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE SENSING AND PERCEPTION SUBSYSTEM OF THE NASA RESEARCH TELEROBOT
B. Wilcox, D. B. Gennery, B. Bon, and T. Litwin *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 3-7 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26513*# California Inst. of Tech., Pasadena.
SPATIALLY RANDOM MODELS, ESTIMATION THEORY, AND ROBOT ARM DYNAMICS
G. Rodriguez *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 177-184 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26514*# Integrated Systems, Inc., Palo Alto, CA.
TASK ORIENTED NONLINEAR CONTROL LAWS FOR TELEROBOTIC ASSEMBLY OPERATIONS
R. A. Walker, L. S. Ward, and C. F. Elia *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 185-195 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26515*# Hewlett-Packard Co., Cupertino, CA.
A UNIVERSAL SIX-JOINT ROBOT CONTROLLER
D. G. Bihn and T. C. Hsia (California Univ., Davis.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 197-206 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26517*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MANIPULATOR CONTROL AND MECHANIZATION: A TELEROBOT SUBSYSTEM
S. Hayati and B. Wilcox *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 219-227 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26518*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CHAOS MOTION IN ROBOT MANIPULATORS
A. Lokshin and M. Zak *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 229-234 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26519*# Carnegie-Mellon Univ., Pittsburgh, PA.
EFFECT OF CONTROL SAMPLING RATES ON MODEL-BASED MANIPULATOR CONTROL SCHEMES
P. K. Khosla *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 235-243 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26520*# Scientific Systems, Inc., Cambridge, MA.
KINEMATICALLY REDUNDANT ROBOT MANIPULATORS
J. Baillieul, J. Hollerbach, R. Brockett (Harvard Univ., Cambridge, MA.), D. Martin, R. Percy, and R. Thomas *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 245-255 Prepared in cooperation with Boston Univ., MA (For primary document see N89-26492 20-63)
(Contract F33615-84-C-5131)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26521*# California Univ., Los Angeles.
CONTROL STRATEGY FOR A DUAL-ARM MANEUVERABLE SPACE ROBOT
P. K. C. Wang *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 257-266 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26524*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FLEXIBLE TELEROBOTIC SYSTEM FOR SPACE OPERATIONS
N. O. Sliwa and R. W. Will *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 285-292 Previously announced in IAA as A87-23229 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26526*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COORDINATION OF MULTIPLE ROBOT ARMS
L. K. Barker and D. Soloway *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 301-305 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26527*# American Welding Inst., Louisville, TN.
DEVELOPMENT OF A SEMI-AUTONOMOUS SERVICE ROBOT WITH TELEROBOTIC CAPABILITIES
J. E. Jones and D. R. White (MTS Systems Corp., Minneapolis, MN.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 307-316 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26528*# Martin Marietta Aerospace, Denver, CO.
A TASK-BASED METRIC FOR TELEROBOTIC PERFORMANCE ASSESSMENT
J. F. Barnes *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 317-324 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26529*# Clemson Univ., SC.
MOTION COORDINATION AND PROGRAMMABLE TELEOPERATION BETWEEN TWO INDUSTRIAL ROBOTS
J. Y. S. Luh and Y. F. Zheng *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 325-334 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26530*# ORINTEC, Vallejo, CA.
USE OF CONTROL UMBILICALS AS A DEPLOYMENT MODE FOR FREE FLYING TELEROBOTIC WORK SYSTEMS
J. S. Kuehn and E. D. Selle *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 335-339 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26531*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE DESIGN OF A NINE-STRING SIX-DEGREE-OF-FREEDOM FORCE-FEEDBACK JOYSTICK FOR TELEMANIPULATION
M. L. Agronin *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 341-348 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26534*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TASK-LEVEL TESTING OF THE JPL-OMV SMART END EFFECTOR
B. Hannaford *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 371-379 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26537*# Massachusetts Inst. of Tech., Cambridge.
MIT RESEARCH IN TELEROBOTICS
T. B. Sheridan *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 403-412 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26551*# Minnesota Univ., Minneapolis.
KNOWLEDGE REPRESENTATION SYSTEM FOR ASSEMBLY USING ROBOTS
A. Jain and M. Donath *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 101-113 (For primary document see N89-26541 20-63)
(Grant NSF DMC-83-51827)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26558*# Carnegie-Mellon Univ., Pittsburgh, PA.
DESIGN OF A RECONFIGURABLE MODULAR MANIPULATOR SYSTEM
D. Schmitz and T. Kanade *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 171-178 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26559*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NONLINEAR FEEDBACK CONTROL OF MULTIPLE ROBOT ARMS
T. J. Tarn, X. Yun (Washington Univ., Saint Louis, MO.), and A. K. Bejczy *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 179-191 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26560*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
DYNAMICS AND CONTROL OF COORDINATED MULTIPLE MANIPULATORS
S. A. Hayati *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 193-203 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26567*# University of Southern Illinois, Carbondale.
ADAPTIVE HYBRID POSITION/FORCE CONTROL OF ROBOTIC MANIPULATORS
F. Pourboghrat *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 273-277 (For primary document see N89-26541

20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26569*# Ohio State Univ., Columbus.
DUAL ARM ROBOTIC SYSTEM WITH SENSORY INPUT
U. Ozguner *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 289-297 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26571*# Old Dominion Univ., Norfolk, VA.
REDUCING MODEL UNCERTAINTY EFFECTS IN FLEXIBLE MANIPULATORS THROUGH THE ADDITION OF PASSIVE DAMPING
T. E. Alberts *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 307-316 Prepared in cooperation with Georgia Inst. of Tec h., Atlanta (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26574*# Massachusetts Inst. of Tech., Cambridge.
A VIRTUAL MANIPULATOR MODEL FOR SPACE ROBOTIC SYSTEMS
S. Dubowsky and Z. Vafa *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 342-344 (For primary document see N89-26541 20-63)
(Grant NAG1-489)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26575*# Purdue Univ., West Lafayette, IN.
MODEL REDUCTION FOR DISCRETE BILINEAR SYSTEMS
A. M. King and R. E. Skelton *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 345-354 Sponsored in part by Hughes Aircraft Company (For primary document see N89-26541 20-63)
(Grant NSF MEA-84-05133)
Avail: NTIS HC A18/MF A01 CSCL 13I

N89-26577*# Ametek, Inc., Santa Barbara, CA.
CONCEPT DEVELOPMENT OF A TENDON ARM MANIPULATOR AND ANTHROPOMORPHIC ROBOTIC HAND
C. T. Tolman *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 365-371 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

N89-26247# Missouri Univ., Columbia. Dept. of Statistics.
INTERNATIONAL RESEARCH CONFERENCE ON RELIABILITY Final Report, 1 Apr. - 30 Sep. 1988
Asit P. Basu 10 Nov. 1988 8 p
(Grant AF-AFOSR-0144-88; AF Proj. 2304)
(AD-A207001; AFOSR-89-0377TR) Avail: NTIS HC A02/MF A01 CSCL 12/3

An international research conference on reliability was held at the University of Missouri-Columbia, Missouri, May 17-19, 1988. The primary purpose of the conference is to bring together researchers from industry, government and universities so that they may exchange ideas to identify directions for future relevant research in reliability. Here reliability is interpreted in its broadest sense. The conference is planned by the Research Subcommittee of the American Statistical Association Productivity and Quality Committee and is sponsored by the University of Missouri. Other organizations are also expected to sponsor the conference. The program will consist of invited and contributed papers on a broad spectrum of topics. Among proposed topics are: Accelerated Tests, Artificial Intelligence and Expert Systems, Automatic Diagnostics of Complex Systems, Bayesian Reliability, DataBase Analysis; Network Reliability; Government Documents on Reliability; Reliability Growth; Reliability Management; Repairable Systems; and Software Reliability. GRA

N89-26248# Oxford Univ. (England). Dept. of Engineering Science.
ON LINE FAULT DETECTION: A SYSTEM-NONSPECIFIC APPROACH Ph.D. Thesis
D. W. McMichael 1988 258 p
(OUEL-1729/88; ETN-89-94816) Avail: NTIS HC A12/MF A01

Work on recursive estimation and fault detection is described. A recursive estimator based on Lp cost minimization, both robust and globally convergent, is presented. The problem of incorporation of prior information and side constraints in least square estimation is examined. A general method applicable to all linear prediction error estimators is presented. Algorithms for online fault detection are described. Their value is shown in simulation studies. ESA

N89-26249# Technische Univ., Eindhoven (Netherlands).
PERFORMANCE EVALUATION AND A QUALITY CONTROL SYSTEM FOR THREE COORDINATE MEASURING MACHINES Ph.D. Thesis
Johannes Wilhelmus M Teeuwsen 1988 150 p
(ETN-89-94884) Avail: NTIS HC A07/MF A01

In order to describe the effects of deviation sources on three-coordinate measuring machines (CMM), the following models are developed: the geometric model, the mass force model, and the thermal model respectively. The semicontinuous measuring method, involving measuring instruments used for data acquisition on the geometrical quantities of the CMM, is automated. The data acquistion of the characteristic thermal quantities of the CMM is incorporated in the automated measurement set-up. Based on the theoretical models and measurement procedures, a practical quality control system is developed with which to monitor the performance of the CMM with respect to its volumetric measuring accuracy. A simple and practical numerical error correction method is developed. The effects of environmental vibrations, and the effects induced by the accelerations of the machine components are considered. ESA

39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

N89-26250 Pennsylvania State Univ., University Park.
AN ONSITE EXPERIMENTAL TESTING-IDENTIFICATION METHOD FOR ESTIMATION OF STRUCTURAL MODAL PARAMETERS Ph.D. Thesis
Gun-Myung Lee 1988 187 p
Avail: Univ. Microfilms Order No. DA8826776

An onsite experimental vibration modal testing and identification approach was developed and evaluated. With this approach a modal model is estimated and its quality is evaluated onsite as opposed to off-line processing. Repeated testing and quality assessment enable a high quality model to be estimated at each test point before moving to the next position. The approach employs the least squares time domain method as the identification algorithm. The algorithm can extract accurate modal parameters with a small amount of data in a computationally efficient fashion. The modal testing approach can quantitatively assess the modal model quality in band limited frequency ranges by comparing the model predicted response to the measured one in narrow bands

with the aid of digital filters. The convergence factor representing the pole convergence rate provides a quantitative means to separate structural modes from computational ones. Structural nonlinearities can be detected and characterized by monitoring the variation of the estimated modal parameters with excitation level. The overall utility of the onsite testing approach was demonstrated in a series of experimental tests. Author

N89-26251 Surrey Univ., London (England).
PLASTIC DEFORMATION AROUND INDENTATIONS AND THEIR EFFECT ON FATIGUE CYCLING Ph.D. Thesis
Abdur-Razzaq 1988 236 p
Avail: Univ. Microfilms Order No. BRDX84083

An attempt was made to make a compreshensive study of the plastic deformation around indentations and to study their effect on the low amplitude fatigue cycling of mono and polycrystalline copper. This effect has been studied using both surface as well as transmission electron microscope (TEM) observations. The project was divided into four main categories; a study of the deformation around indentations; a study of the fatigue cycling mechanism; a study of the low strain amplitude fatigue cycling of the indented specimens and a study of the effect of indentation on the fatigued specimens. The surface topographical studies were made on specially designed polycrystalline and single crystal specimens of copper. The transmission electron microscope study was done mainly on thin strips sliced and prepared from two bulk single crystals with axial orientation close to (1(-)24) and (012). The dislocation structures due to indentations were studied in regions at different positions in relation to the indentations and included a study of the microstructures close to the surface as well as approximately equal to 50 micrometers from it. Specimens were fatigued in air, at room temperature, at total strain amplitudes in the range approximately 2 x 10(-4) to 9.9 x 10(-4) for bulk specimens and approximately equal to 0.8 x 10(-3) to 1.9 x 10(-3) for thin foil specimens. The number of fatigue cycles given to the specimens varied (from specimen to specimen) from a few cycles to several hundred thousand cycles. The Dyer model (1965) was satisfactorily extended from ball to pyramid indentations to explain the hill formation and the general surface topography around indentations. Dislocation microstructures around indentations in the indented and indented and fatigued specimens of the same orientation were analyzed and compared. Dissert. Abstr.

N89-26252 Columbia Univ., New York, NY.
CRACK EXTENSION UNDER DYNAMIC LOADING Ph.D. Thesis
Xiaogong Lee 1988 100 p
Avail: Univ. Microfilms Order No. DA8827605

Crack propagation problems under dynamic loading is studied. The analysis is performed within the assumption of linear elastic fracture mechanics for the condition of plane strain in an infinite body. Mode 1 and Mode 2 cracks are considered. The basic equations used for the problems are two coupled integral equations in space and time which express the continuity of displacements in the plane of the crack, ahead of the crack tip. The unknown functions and these equations are the normal and the shear stresses in the plane of the crack. The kernels of these equations, or the influence functions, are the displacements corresponding to the unit line impulses acting on the half-space bounded by the plane of the crack. The load acting on a body with a pre-existing crack is assumed to have the form of a transient stress wave with normal and shear stress components. This analysis is also applied to study the dynamic effects of a crack propagating in a body subjected to static loads. The integral equations in space and time are reduced to two coupled Volterra equations in time by assuming a spatial distribution of unknown stresses with square-root singularities at the crack tip and with a time-dependent stress intensity factor. A numerical procedure is developed for the solution of the Volterra equations. A closed-form expression for the stress intensity factor as a function of the crack-tip velocity is derived for the case of a semi-infinite crack in a body under a uniform static state of stress. In the case of a body subjected to a transient stress wave, the stress intensity factor is determined for a given crack-tip velocity. In order to determine the crack tip velocity under a given transient stress wave, a simple hypothesis concerning the crack propatation criterion is adopted in terms of the stress intensity factor. A numerical procedure for the calculation of the time-dependent crack-tip velocity is proposed. Dissert. Abstr.

N89-26253 Old Dominion Univ., Norfolk, VA.
A FINITE ELEMENT FORMULATION FOR THE LARGE DEFLECTION RANDOM RESPONSE OF THERMALLY BUCKLED STRUCTURES Ph.D. Thesis
James Eugene Locke 1988 136 p
Avail: Univ. Microfilms Order No. DA8823956

The effects of temperature and acoustic loading are included in a theoretical finite element large deflection formulation for thin, isotropic plate and beam type structures. Thermal loads are applied as steady-state temperature distributions, and acoustic loads are taken to be stationary and Gaussian with zero mean and uniform magnitude and phase over the surface of the structure. The nature of the loads leads to the solution of two separate problems. First, the problem of thermal postbuckling is solved to determine the deflections and stresses due to the thermal load only. These deflections and stresses are then used as initial deflections and stresses for the random vibration analysis. Since both analyses are nonlinear, iterative techniques are used to solve each. The solution technique used for the thermal postbuckling analysis is that of Newton-Raphson iteration. Instead of using direct iteration, an underrelaxation technique is employed to reduce the number of iterations required for a converged solution. Solutions obtained using these analysis methods are compared with previous solutions to assess the accuracy of the finite element formulation. The thermal postbuckling solution is compared with a 25-mode classical solution for a square plate clamped on all edges, and the random vibration solution is compared with 100-mode classical beam solutions. Dissert. Abstr.

N89-26254*# Analytical Services and Materials, Inc., Hampton, VA.
TREATMENT OF SINGULARITIES IN CRACKED BODIES
K. N. Shivakumar and I. S. Raju May 1989 46 p
(Contract NAS1-18599)
(NASA-CR-181840; NAS 1.26:181840) Avail: NTIS HC A03/MF A01 CSCL 20K

Three-dimensional finite-element analyses of middle-crack tension (M-T) and bend specimens subjected to mode I loadings were performed to study the stress singularity along the crack front. The specimen was modeled using 20-node isoparametric elements. The displacements and stresses from the analysis were used to estimate the power of singularities using a log-log regression analysis along the crack front. The analyses showed that finite-sized cracked bodies have two singular stress fields of the form rho = C sub o (theta, z) r to the -1/2 power + D sub o (theta, phi) R to the lambda rho power. The first term is the cylindrical singularity with the power -1/2 and is dominant over the middle 96 pct (for Poisson's ratio = 0.3) of the crack front and becomes nearly zero at the free surface. The second singularity is a vertex singularity with the vertex point located at the intersection of the crack front and the free surface. The second term is dominant at the free surface and becomes nearly zero away from the the boundary layer. The thickness of the boundary layer depends on Poisson's ratio of the material and is independent of the specimen type. The thickness of the boundary layer varied from 0 pct to about 5 pct of the total specimen thickness as Poisson's ratio varied from 0.0 to 0.45. Because there are two singular stress fields near the free surface, the strain energy release rate (G) is an appropriate parameter to measure the severity of the crack. Author

N89-26255*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DERIVATION OF A TAPPERED p-VERSION BEAM FINITE ELEMENT
Howard E. Hinnant (Army Aviation Systems Command, Hampton, VA.) Aug. 1989 45 p

(DA Proj. 1L1-62211-A-47-AB)
(NASA-TP-2931; L-16577; NAS 1.60:2931; AVSCOM-TR-B-002)
Avail: NTIS HC A03/MF A01 CSCL 20K

A tapered p-version beam finite element suitable for dynamic applications is derived. The taper in the element is represented by allowing the area moments of inertia to vary as quartic polynomials along the length of the beam, and the cross-sectional area to vary as a quadratic polynomial. The p-version finite-element characteristics are implemented through a set of polynomial shape functions. The lower-order shape functions are identical to the classical cubic and linear shape functions normally associated with a beam element. The higher-order shape functions are a hierarchical set of polynomials that are integrals of orthogonal polynomials. Explicit expressions for the mass and stiffness matrices are presented for an arbitrary value of p. The element has been verified to be numerically stable using shape functions through 22nd order. Author

N89-26256# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.

FOUNDATION OF A MECHANO-CHEMICAL FATIGUE THEORY (MCFT)

E. Altus (Israel Inst. of Tech., Haifa.) Feb. 1989 48 p
(Grant OCMR-TP2-325)
(UTIAS-330; ISSN-0082-5255) Avail: NTIS HC A03/MF A01

A theory which identifies the chemical reaction between a broken molecule and its neighbor as the main micro-scale source of fatigue failure is developed. By applying statistical laws, the macro-behavior of the material is revealed. Three types of macro damage accumulation functions emerge, as a direct result of different values of the micro-scale parameters. The reference type shows secondary and tertiary stages, the second type includes an additional primary stage, and the third type, leading to a material with a specific endurance limit, has only a primary stage. An empirical power-law relationship between the stress level and the number of cycles to failure is obtained analytically by the theory for the reference type of damage, when a Weibull strength distribution function for the molecules is used. Three microscopic material parameters control the macro-behavior: (1) a statistical shape parameter, describing the strength distribution of the molecular chains; (2) a stress concentration factor, which describes the amount of weakening a broken chain can cause to its neighbor; and (3) a probability function for a chemical reaction to occur. The micro-scale roots of the theory enables the use of physical internal variables for the damage evolution equations. Thus, a clear interpretation of the macro-fatigue response, including the existence of an endurance limit is achieved. Experimental correlations with available fatigue data for different materials, including metals, plastics and composites, show the general validity of the theory, not only for polymeric interfaces. This is due to the mechano-chemical mechanism, on which the theory is based. The mathematical similarity of the basic equations to the ones found in chaotic theories is demonstrated and discussed briefly. Author

N89-26257*# North Carolina State Univ., Raleigh. Mechanical and Aerospace Engineering.

SHEAR BUCKLING OF SPECIALLY ORTHOTROPIC PLATES WITH CENTRALLY LOCATED CUTOUTS Semiannual Report

Eric C. Klang and Vicki Owen Jun. 1989 22 p
(Grant NAG1-917)
(NASA-CR-185346; NAS 1.26:185346) Avail: NTIS HC
A03/MF A01 CSCL 20K

The shear loading of a composite rectangular plate with a centrally located circular cutout was analyzed in order to predict the buckling load of the plate. The first step in this analysis is to calculare the in-plane stress distribution of the plate prior to buckling. This problem can be solved using finite element methods, but a quicker and more cost efficient method is desired. The method chosen to determine the pre-buckling stresses is that of boundary collocation using complex variables. The real valued force functions are written in terms of two complex valued functions, each of which is a function of a different complex variable. The solution of the generalized biharmonic function is a superposition of functions of these two complex variables. For this analysis, the force functions are represented with a Laurent series. The constants in these series are found using boundary collocation. Two force equations for complex variables are satisfied over the plate boundaries to obtain these constants. The stresses in the plate are then known for any particular locations on the plate given the applied shear on the edges of the plate. Author

N89-26258*# Virginia Polytechnic Inst., Blacksburg. Dept. of Engineering and Mechanics.

MECHANICAL RESPONSE OF THICK LAMINATED BEAMS AND PLATES SUBJECT TO OUT-OF-PLANE LOADING

C. C. Hiel and . F. Brinson 1989 46 p
(Contract NCC2-71)
(NASA-CR-185391; NAS 1.26:185391) Avail: NTIS HC
A03/MF A01 CSCL 20K

The use of simplified elasticity solutions to determine the mechanical response of thick laminated beams and plates subject to out-of-plane loading is demonstrated. Excellent results were obtained which compare favorably with theoretical, numerical and experimental analyses from other sources. The most important characteristic of the solution methodology presented is that it combines great mathematical precision with simplicity. This symbiosis has been needed for design with advanced composite materials. Author

N89-26259*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPUTATIONAL STRUCTURAL MECHANICS FOR ENGINE STRUCTURES

C. C. Chamis 1989 12 p Presented at the 30th Structures, Structural Dynamics and Materials (SDM) Conference, Mobile, AL, 3-5 Apr. 1989; cosponsored by the AIAA, ASME, ASCE, AHS, and ACS
(NASA-TM-102119; E-4898; NAS 1.15:102119) Avail: NTIS HC
A03/MF A01 CSCL 20K

The computational structural mechanics (CSM) program at Lewis encompasses: (1) fundamental aspects for formulating and solving structural mechanics problems, and (2) development of integrated software systems to computationally simulate the performance/durability/life of engine structures. It is structured to mainly supplement, complement, and whenever possible replace, costly experimental efforts which are unavoidable during engineering research and development programs. Specific objectives include: investigate unique advantages of parallel and multiprocesses for: reformulating/solving structural mechanics and formulating/solving multidisciplinary mechanics and develop integrated structural system computational simulators for: predicting structural performances, evaluating newly developed methods, and for identifying and prioritizing improved/missing methods needed. Herein the CSM program is summarized with emphasis on the Engine Structures Computational Simulator (ESCS). Typical results obtained using ESCS are described to illustrate its versatility. Author

N89-26260*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NONLINEAR MESOMECHANICS OF COMPOSITES WITH PERIODIC MICROSTRUCTURE Rept. No. 1

Kevin P. Walker, Eric H. Jordan (Connecticut Univ., Storrs.), and Alan D. Freed Jun. 1989 82 p
(Grant NAG3-882)
(NASA-TM-102051; E-4670; NAS 1.15:102051) Avail: NTIS HC
A05/MF A01 CSCL 20K

This work is concerned with modeling the mechanical deformation or constitutive behavior of composites comprised of a periodic microstructure under small displacement conditions at elevated temperature. A mesomechanics approach is adopted which relates the microimechanical behavior of the heterogeneous composite with its in-service macroscopic behavior. Two different methods, one based on a Fourier series approach and the other on a Green's function approach, are used in modeling the micromechanical behavior of the composite material. Although the

constitutive formulations are based on a micromechanical approach, it should be stressed that the resulting equations are volume averaged to produce overall effective constitutive relations which relate the bulk, volume averaged, stress increment to the bulk, volume averaged, strain increment. As such, they are macromodels which can be used directly in nonlinear finite element programs such as MARC, ANSYS and ABAQUS or in boundary element programs such as BEST3D. In developing the volume averaged or efective macromodels from the micromechanical models, both approaches will require the evaluation of volume integrals containing the spatially varying strain distributions throughout the composite material. By assuming that the strain distributions are spatially constant within each constituent phase-or within a given subvolume within each constituent phase-of the composite material, the volume integrals can be obtained in closed form. This simplified micromodel can then be volume averaged to obtain an effective macromodel suitable for use in the MARC, ANSYS and ABAQUS nonlinear finite element programs via user constitutive subroutines such as HYPELA and CMUSER. This effective macromodel can be used in a nonlinear finite element structural analysis to obtain the strain-temperature history at those points in the structure where thermomechanical cracking and damage are expected to occur, the so called damage critical points of the structure. Author

N89-26261*# Akron Univ., OH. Dept. of Civil Engineering.
ON FINITE ELEMENT IMPLEMENTATION AND COMPUTATIONAL TECHNIQUES FOR CONSTITUTIVE MODELING OF HIGH TEMPERATURE COMPOSITES Final Report
A. F. Saleeb, T. Y. P. Chang, T. Wilt, and I. Iskovitz Jul. 1989 157 p
(Grant NAG3-901)
(NASA-CR-185120; NAS 1.26:185120) Avail: NTIS HC A08/MF A01 CSCL 20K

The research work performed during the past year on finite element implementation and computational techniques pertaining to high temperature composites is outlined. In the present research, two main issues are addressed: efficient geometric modeling of composite structures and expedient numerical integration techniques dealing with constitutive rate equations. In the first issue, mixed finite elements for modeling laminated plates and shells were examined in terms of numerical accuracy, locking property and computational efficiency. Element applications include (currently available) linearly elastic analysis and future extension to material nonlinearity for damage predictions and large deformations. On the material level, various integration methods to integrate nonlinear constitutive rate equations for finite element implementation were studied. These include explicit, implicit and automatic subincrementing schemes. In all cases, examples are included to illustrate the numerical characteristics of various methods that were considered. Author

N89-26262*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON THE STATE ESTIMATION OF STRUCTURES WITH SECOND ORDER OBSERVERS
W. Keith Belvin and K. C. Park (Colorado Univ., Boulder.) May 1989 9 p Presented at the 39th AIAA, ASME, et al., 30th Structures, Structural Dynamics and Materials Conference, Mobile, AL, 3-5 Apr. 1989 Previously announced in IAA as A89-30726
(Contract F49620-87-C-0074)
(NASA-TM-101602; NAS 1.15:101602) Avail: NTIS HC A02/MF A01 CSCL 20K

The use of Linear Quadratic Regulator (LQR) control synthesis techniques implies the availability of full state feedback. For vibration control of structures, usually only a limited number of states are measured from which an observer model reconstructs the full state. It is shown that using second order observers is a viable technique for reconstructing the unmeasured states of structures under mildly restrictive conditions. Moreover, the computational advantages of the second order observer as compared to a first order observer indicate that significantly larger observer models may be utilized. Numerical examples are used to demonstrate the performance of second order observers. The implications of second order observers in the development of Controls-Structures Interaction (CSI) technology is discussed. Author

N89-26263# Northwestern Univ., Evanston, IL. Dept. of Civil Engineering.
DYNAMIC RESPONSE OF EMBEDDED STRUCTURES Final Report, 15 Jan. 1986 - 14 Jan. 1989
Leon M. Keer and Surendra P. Shah 14 Jan. 1989 26 p
(Grant AF-AFOSR-0058-86; AF Proj. 2302)
(AD-A206682; AFOSR-89-0421TR) Avail: NTIS HC A03/MF A01 CSCL 13/13

A shock impulse environment simulated by low velocity impact (free-drop impact system) was developed to generate a well characterized dynamic loading on the free surface. Low velocity impact of a circular plate resting on sand provided the vehicle by which the dynamic loading on the free surface was characterized. An analysis based on linear elastodynamics was derived for transient waves on a thin plate resting on an elastic half-space (sand). The results provide an understanding of plate vibration (foundation vibration), of the interaction between the plate and the sand, and of the propagation of the load into the sand. The dynamic behavior of a typical elastic buried structure was studied by using plexiglass; where as micro reinforced-concrete was used to study the behavior of a buried reinforced concrete structure. Loading relief at the center of the roof of the buried structures was observed. Furthermore, the Stiffer structure was observed to the experience loss soil arching. When a linear-elastic dynamic analysis by the finite element method was conducted, the numerical results were found to have good correlation with the experimental observation of the peak displacement on the buried roof. However, the behavior after the peak response can not be simulated using the current linear elastic formulation. GRA

N89-26264# Stanford Univ., CA. Dept. of Mechanical Engineering.
NUMERICAL EVALUATION AND COMPARISON OF SUBCYCLING ALGORITHMS FOR STRUCTURAL DYNAMICS Technical Report, 27 Sep. 1984 - 29 Jan. 1988
G. M. Hulbert and T. J. Hughes 20 Sep. 1988 76 p
(Contract DNA001-84-C-0306)
(AD-A206756; DNA-TR-88-8) Avail: NTIS HC A05/MF A01 CSCL 12/1

This report compares numerical results obtained from seven proposed subcycling algorithms which were used to solve three test problems. The numerical results show that three of the subcycling algorithms - TRANAL, and the linear and quadratic nodal interpolation schemes - produced accurate and stable solutions. The free element partition algorithm produced stable but significantly inaccurate results for two of the three test problems. Subsequently, the two best algorithms - TRANAL and the linear nodal interpolation algorithm - were used to solve a larger test problem. GRA

N89-26265# Brown Univ., Providence, RI. Div. of Applied Mathematics.
IMPULSIVE LOADING OF FIBER-REINFORCED STRUCTURES Final Report, 1 Feb. 1986 - 31 Dec. 1988
Herbert Kolsky and Allen Pipkin 1 Mar. 1989 23 p
(Grant AF-AFOSR-0157-87; AF Proj. 2302)
(AD-A206989; AFOSR-89-0469TR) Avail: NTIS HC A03/MF A01 CSCL 20/11

The work described concerns the response of metallic composite beams and simple structures to rapid dynamic loading. It was shown experimentally that the observed plastic response of clamped beam specimens to very sharp transverse blows could be adequately described by the idealised theory formulated by Spencer and his colleagues so long as the duration was sufficiently short for the plastic wave not to reach the clamp. The reflection process for real clamping conditions was found to very much more

complex. The effects of blows of much longer durations on beams and portal arches are also described, as well as the effects of rate-of strain on the yield point of the matrix metal. GRA

N89-26266# Stanford Univ., CA. Dept. of Mechanical Engineering.
MATHEMATICAL MODELING AND NUMERICAL SIMULATION OF THE DYNAMICS OF FLEXIBLE STRUCTURES SUBJECT TO LARGE OVERALL MOTIONS Final Report, 31 Jul. 1986 - 30 Jul. 1988
J. C. Simo 1989 19 p
(Grant AF-AFOSR-0292-86; AF Proj. 2304)
(AD-A207004; AFOSR-89-0425TR) Avail: NTIS HC A03/MF A01 CSCL 20/11

A new modelling and computational task for the integrated design of flexible structures undergoing large overall motions has been developed and analyzed. This new approaches utilizes geometrically exact structured models and have the advantage that these models can handle coupled rigid body-flexible appendage systems without resorting to the introduction of the so-called floating frames. GRA

N89-26267# Northrop Corp., Hawthorne, CA. Aircraft Div.
AUTOMATED STRUCTURAL OPTIMIZATION SYSTEM (ASTROS): USER TRAINING WORKSHOP Final Report, Jul. 1983 - Jun. 1988
E. H. Johnson, D. J. Neill, D. L. Herendeen, and R. A. Canfield (Department of the Air Force, Wright-Patterson AFB, OH.) Mar. 1989 427 p
(Contract F33615-83-C-3232)
(AD-A207090; AFWAL-TR-88-3101) Avail: NTIS HC A19/MF A01 CSCL 12/5

The ASTROS (Automated Structural Optimization System) procedure provides multidisciplinary analysis and design capability for aerospace structures. The engineering analysis capabilities in the system include structural analysis (static and dynamic), aeroelastic analysis (static and dynamic) and automated design. A specifically designed data base and executive system were implemented to maximize the system's efficiency, flexibility, and maintainability. The charts used in the ASTROS User Training Workshop, conducted by the Air Force and Northrop are presented in this report. GRA

N89-26268*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
O-RING SEALING VERIFICATION FOR THE SPACE SHUTTLE REDESIGN SOLID ROCKET MOTOR
Cynthia L. Lach May 1989 117 p
(NASA-TM-101591; NAS 1.15:101591) Avail: NTIS HC A06/MF A01 CSCL 20K

As a part of the redesign of the Space Shuttle Solid Rocket Motor, the field and nozzle-to-case joints were redesigned to minimize the dynamic flexure caused by internal motor pressurization during ignition. The O-ring seals and glands for the joints were designed to accommodate both structural deflections and to promote pressure assistance. A test program was conducted to determine if a fluorocarbon elastomeric O-ring could meet this criteria in the redesigned gland. Resiliency tests were used to investigate the O-ring response to gap motion while static seal tests were used to verify design criteria of pressure assistance for sealing. All tests were conducted in face seal fixtures mounted in servo-hydraulic test machines. The resiliency of the O-ring was found to be extremely sensitive to the effects of temperature. The External Tank/Solid Rocket Booster attach strut loads had a negligible affect on the ability of the O-ring to track the simulated SRB field joint deflection. In the static pressure-assisted seal tests, as long as physical contact was maintained between the O-ring and the gland sealing surface, pressure assistance induced instantaneous sealing. Author

N89-26269# Karlsruhe Univ. (Germany, F.R.).
TRANSVERSE VIBRATION OF A CIRCULAR CYLINDER NEAR A SOLID BOUNDARY
B. C. Syamalaro Nov. 1988 21 p
(KU-SFB-210/E/51; ETN-89-94602) Avail: NTIS HC A03/MF A01

Experiments are carried out on the transverse vibration of a circular cylinder near a wall for gap (s) sizes from 0 to 8 times the diameter (d) of the cylinder. For s/d greater than 2, vortex-excited vibrations occur in the range 4.5 less than Vr less than 10. A second range of vibrations is noticed in the range 3.5 less than Vr less than 4.0. The vibration frequency is close to the natural frequency of the cylinder in both cases. The wall has an increasing influence on the vibration response for gap ratios s/d less than 2. For s/d less than 0.7, the maximum amplitude of vibration is restricted by the gap size and the cylinder impacts the wall. For s/d = 0.2, the frequency of vibration increases with reduced velocity and the maximum vibration frequency is 32 percent higher than the natural frequency. The reduced velocity at vibration onset decreases with decrease in gap ratio. ESA

N89-26270 National Physical Lab., Teddington (England). Div. of Information Technology and Computing.
THE HELMHOLTZ INTEGRAL EQUATION FOR A THIN SHELL
A. G. P. Warham Nov. 1988 72 p Sponsored in part by the United Kingdom Ministry of Defence Procurement Executive, London, England
(NPL-DITC-129/88; ISSN-0262-5369; ETN-89-94824) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW17 0LW, United Kingdom

The interaction between the vibrations of a thin slightly curved shell and the surrounding fluid is considered. Various discretizations of the resulting integral equation are discussed. One such discretization, into piecewise constant elements, is investigated further by numerically evaluating the acoustic radiation produced by a uniformly vibrated flat plate of either square or circular shape. It is found that the errors which arise are approximately proportional to element size, so that in practical computations only modest accuracy can be obtained. ESA

N89-26271# Institut Franco-Allemand de Recherches, Saint-Louis (France).
MATERIAL DYNAMIC PROPERTIES DETERMINATION BY TENSILE IMPACT TESTS ON SAMPLES OF DIFFERENT GEOMETRY [ERMITTLUNG DYNAMISCHER WERKSTOFFKENWERTE MIT DEM ZUG-IMPACT BEI UNTERSCHIEDLICHER PROBENGEOMETRIE]
K. Hoog 10 May 1988 11 p In GERMAN; ENGLISH summary Presented at the 2nd Internationalen Kongress ueber das Mechanische und Physikalische Verhalten von Werkstoffen unter Dynamischer Beanspruchung DYMAT 88, Ajaccio, France, 19-23 Sep. 1988
(ISL-CO-209/88; ETN-89-94849) Avail: NTIS HC A03/MF A01

Specimen geometry effects on the distribution of stresses and deformation is studied by tensile impact tests. Dynamic material characteristics are presented for a specimen of treated steel 35 NDC 16 and a specimen of steel CK 15. Geometry factors studied are sample length and sample conical configuration. Indirect determination of material properties is achieved by comparison of measured deformations with calculated results obtained by finite element code. ESA

N89-26272# Technische Univ., Eindhoven (Netherlands).
PREDICTION OF DUCTILE FAILURE Ph.D. Thesis
Pieter Jan Bolt 1989 154 p
(ETN-89-94883) Avail: NTIS HC A08/MF A01

Theories and experimental observations of ductile failure mechanisms, especially void development, are reviewed; and approaches to handle ductility are given. The development of voids was studied by Finite Element Method (FEM) simulations. It is shown that the work hardening and the pattern of distribution of voids affect the plastic flow of the intervoid material and void coalescence, by which cracks finally initiate. The ratio of void size and spacing is suggested to be an important geometrical parameter with respect to void coalescence. Ductility was repesented empirically by a ductile failure curve. This provides the critical

equivalent strain in dependence of the state of stress at failure. Ductile failures curves were determined for metals, selected in order to study the effect of the state or stress over a wide range of ductilities. Tension and torion tests were performed. The former involved both notched and unnotched specimens and are supported by FEM simulations in order to obtain the local stresses and strains. The more ductile the material, the larger the effect of the state of stress. However, if the equivalent failure strains are normalized to their value for torsion, the effect is similar within the sets of ferrous (low carbon steels) and nonferrous metals employed. ESA

N89-26273*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LANGLEY ROTORCRAFT STRUCTURAL DYNAMICS PROGRAM: BACKGROUND, STATUS, ACCOMPLISHMENTS, PLANS
Raymond G. Kvaternik Jun. 1989 22 p
(NASA-TM-101618; NAS 1.15:101618) Avail: NTIS HC A03/MF A01 CSCL 20K

Excessive vibration is the most common technical problem to arise as a show stopper in the development of a new rotorcraft. Vibration predictions have not been relied on by the industry during design because of deficiencies in finite element dynamic analyses. A rotorcraft structural dynamics program aimed at meeting the industry's long-term needs in this key technical area was implemented at Langley in 1984. The subject program is a cooperative effort involving NASA, the Army, academia, and the helicopter industry in a series of generic research activities directed at establishing the critical elements of the technology base needed for development of a superior finite element dynamics design analysis capability in the U.S. helicopter industry. An executive overview of the background, status, accomplishments, and future direction of this program is presented. Author

42 GEOSCIENCES (GENERAL)

N89-26274*# National Aeronautics and Space Administration, Washington, DC.
PLANETARY GEOSCIENCES, 1988
Maria T. Zuber, ed., Jeff L. Plescia, ed., Odette B. James, ed., and Glenn MacPherson, ed. (Smithsonian Institution, Washington, DC.) Aug. 1989 113 p Original contains color illustrations
(NASA-SP-498; NAS 1.21:498; LC-88-600456) Avail: NTIS HC A06/MF A01 CSCL 08G

Research topics within the NASA Planetary Geosciences Program are presented. Activity in the fields of planetary geology, geophysics, materials, and geochemistry is covered. The investigator's current research efforts, the importance of that work in understanding a particular planetary geoscience problem, the context of that research, and the broader planetary geoscience effort is described. As an example, theoretical modelling of the stability of water ice within the Martian regolith, the applicability of that work to understanding Martian volatiles in general, and the geologic history of Mars is discussed. Author

N89-26275*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
POLAR MICROWAVE BRIGHTNESS TEMPERATURES FROM NIMBUS-7 SMMR: TIME SERIES OF DAILY AND MONTHLY MAPS FROM 1978 TO 1987
Josefino C. Comiso and H. Jay Zwally Jul. 1989 89 p
(Contract NAS5-29386)
(NASA-RP-1223; Rept-89B00167; NAS 1.61:1223) Avail: NTIS HC A05/MF A01 CSCL 04A

A time series of daily brightness temperature gridded maps (October 25, 1978 through August 15, 1987) were generated from all ten channels of the Nimbus-7 Scanning Multichannel Microwave Radiometer orbital data. This unique data set can be utilized in a wide range of applications including heat flux, ocean circulation, ice edge productivity, and climate studies. Two sets of data in polar stereographic format are created for the Arctic region: one with a grid size of about 30 km on a 293 by 293 array similar to that previously utilized for the Nimbus-5 Electrically Scanning Microwave Radiometer, while the other has a grid size of about 25 km on a 448 by 304 array identical to what is now being used for the DMSP Scanning Multichannel Microwave Imager. Data generated for the Antaractic region are mapped using the 293 by 293 grid only. The general technique for mapping, and a quality assessment of the data set are presented. Monthly and yearly averages are also generated from the daily data and sample geophysical ice images and products derived from the data are given. Contour plots of monthly ice concentrations derived from the data for October 1978 through August 1987 are presented to demonstrate spatial and temporal detail which this data set can offer, and to show potential research applications. Author

43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

N89-26276# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
THE IMPACT OF MULTIVIEWING REFLECTANCE DATA ON THE ESTIMATION OF SUSPENDED SEDIMENT CONCENTRATION
Evlyn Marcia LeaodeMoraesNovo Jun. 1988 6 p Presented at the International Geoscience and Remote Sensing Symposium, Edinburgh, Scotland, 12-16 Sep. 1988
(INPE-4607-PRE/1330) Avail: NTIS HC A02/MF A01

An experiment performed is reported which the tests suitability of using reflectance data measured at different viewing geometries to improve the estimation of Suspended Sediment Concentration (SSC). Laboratory simulation of 35 suspended sediment concentrations and 14 different sensing geometries was carried out to derive the SSC reflectance relationship. The results from the stepwise regression supported the idea that multiviewing algorithms provides better estimates of suspended sediment concentration from water reflectance. The standard error of estimate decrease from 89.00mg/l with the multispectral model to 24.39mg/l with the multiviewing model. The explanatory power of viewing variables, however, varied with wavebands. Author

N89-26277# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
UTILIZATION OF TM-LANDSAT DATA FOR MAPPING THE AREAS SUBJECT TO INUNDATION ALONG THE FLOODPLAIN OF THE RIO PARNAIBA [UTILIZACAO DE DADOS TM-LANDSAT PARA O MAPEAMENTO DE AREAS SUBMETIDAS A INUNDACAO NA BACIA DO RIO PARNAIBA]
Teresa GallottiFlorenzano, Sergio dosAnjosFerreiraPinto, Mario ValerioFilho, Evlyn M. L. MoraesNovo, and Hermann J. H. Kux May 1988 68 p In PORTUGUESE; ENGLISH summary Original contains color illustrations
(INPE-4570-RPE/566) Avail: NTIS HC A04/MF A01

Digital and analogic TM-LANDSAT data, for both normal and flood discharge, were used to identify and map those areas subject to inundation along the floodplain of Rio Parniba (NE-Brazil) at its middle and lower section. Analogic images (b/w paper prints) at bands 3 and 4, scale 1:100.000, as well as positive color transparencies, band 3, 4, 5, scale 1:100.000, were analyzed. Using CCT's, multispectral, multitemporal and multitemporal-multispectral, color composites were obtained, in order to complement the analysis of analogic data. The result is a set of 12 thematic maps, at 1:100.000, showing up those floodplain sections that underwent inundation during the flood of 1985. Author

N89-26278# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
EVALUATION OF LANDSAT MSS DATA FOR SUGARCANE FIELD ESTIMATION
Sherry Chou Chen and Maria Cristina R. V. Spiguel Dec. 1988 15 p Presented at the 3rd Brazilian Symposium on Remote Sensing, Rio de Janeiro, 28-30 Nov. 1984
(INPE-4733-PRE/1409) Avail: NTIS HC A03/MF A01

LANDSAT data were used to correlate with LAI, green biomass, percent ground cover, plant population, chlorophyll concentration and plant height for rangeland pasture, wheat, and soybeans. Multitemporal spectral information of sugarcane obtained during the crop year 1982 to 1983 were correlated with cane production and the possibility of using LANDSAT data for yield estimation was evaluated. Sun elevations of the eight LANDSAT data dates were corrected to 44 deg and the digital counts of the 24 sugarcane fields were acquired using an interactive image analysis system for each MSS channel. Correlation analyses were applied to cane yields and vegetation indices (i.e., D57, R75, TVI and PVI) that were derived from single or multidate LANDSAT spectral data. Significant correlation coefficients were found, however, amplitudes of the correlation coefficients were not high enough for a direct application on sugarcane yield estimation. Author

N89-26279# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
MICROWAVE REMOTE SENSING DATA FROM A SPACEBORNE PLATFORM AS A TOOL TO MONITOR THE HYDROLOGICAL CYCLE OF A FLOODPLAIN AREA (VARZEA) AT NORTHEAST BRAZIL. TEST SITE: PETROLINA, PERNAMBUCO STATE, BRAZIL
J. V. Soares, H. J. H. Kux, U. W. Palme, Sherry Chou Chen, G. F. Banon, A. C. Schiffino, I. B. Sa, E. N. Choudhury, and G. Cordeiro (Empresa Brasileiro de Pesquisa Agropecuaria, Planaltina.) Nov. 1988 25 p
(INPE-4741-RPE/579) Avail: NTIS HC A03/MF A01

The multiparameter characteristics of the SIR-C/X-SAR experiment (L, C and X bands, HH, HV and VV polarizations for L and C bands VV for X band, angles of incidence from 15 to 55 degrees) would provide an unique and excellent opportunity to improve hydrologic and agricultural studies in the microwave domain. Being so, two main objectives are established in this proposal: (1) to develop an algorithm to monitor the hydrological cycle over agricultural areas, based on data derived from SAR imagery and meteorologic data at a floodplain area; and (2) to verify the possibility to discriminate among cultures at the date of the experiment and describe and analyze the attenuation properties of the cultures as related to the following radar parameters: frequency, polarization and angle of incidence. Author

N89-26280# Army Cold Regions Research and Engineering Lab., Hanover, NH.
AIRBORNE RADAR SURVEY OF A BRASH ICE JAM IN THE ST. CLAIR RIVER
Steven F. Daly and Steven A. Arcone Feb. 1989 24 p
(AD-A206868; CRREL-89-2) Avail: NTIS HC A03/MF A01 CSCL 08/12

A brash ice jam in the South Channel of the St. Clair River was profiled in February 1987 using a helicopter-borne short-pulse radar operating in the UHF band near 500 MHz. During the same time, measurements of the brash ice depth and water temperature were made from a Coast Guard icebreaker. The returned radar pulses consisted of a strong coherent reflection from the water surface, preceded (and followed) by incoherent returns from the brash ice. The measured waveform time delays were then converted to mean freeboard height of the brash ice pieces above the water surface. Given the mean freeboard height, an estimate of the total brash ice thickness was made. This estimate was greater than the range of the direct shipboard measurements. The difference is believed due to differences between ice porosity above and below the water line, to melting within the ice and to partial submergence of some of the surface pieces. It is concluded that this technique could be used for mapping relative brash ice depth if the complexities of automating waveform analysis could be overcome. GRA

N89-26281# Army Engineer Studies Center, Fort Belvoir, VA.
SPATIAL TARGET LOCATION ERRORS DERIVED FROM MEASUREMENTS COLLECTED FROM SIXTEEN SATELLITE CONSTELLATIONS Technical Report, Sep. - Nov. 1987
Michael A. Crombie Mar. 1989 161 p
(AD-A206950; ETL-0532) Avail: NTIS HC A08/MF A01 CSCL 17/11

Tables of sample cumulative probability distributions of minimum PDOP values and shortest distances between target and target trackers were developed, where the target is a spatial one and where the target trackers are constrained to any one of 16 satellite constellations. Shortest distance was used as a parameter in this work because target location errors involving direction to target increases as distance to target increases. The tables pertain to the first, second, and third shortest distance and to minimum PDOP's computed from slant range observations taken from 3,4 or 5 target trackers. Tables of expected values of minimum PDOP's and shortest distances are also provided. Values in the tables of expected values of minimum PDOP's and tables of shortest distances can be combined with a prior error analysis to determine 99 percent confidence sphere radii about estimated target locations. Values of minimum PDOP's can be used to determine 99 percent confidence sphere radii about target locations estimated from 3,4, or 5 slant range observations. GRA

N89-26282# Coastal Engineering Research Center, Vicksburg, MS.
COASTAL OCEAN DYNAMICS APPLICATIONS RADAR (CODAR) REMOTE SENSING DEMONSTRATION PROGRAM Final Report
David B. Driver, Edward F. Thompson, Linda S. Lillycrop, and Gregory A. Barrick Mar. 1989 104 p
(AD-A207079; CERC-MP-89-3) Avail: NTIS HC A06/MF A01 CSCL 08/3

This report describes the planning, execution, and results of two major field experiments conducted to determine the wave measuring capabilities of the Coastal Ocean Dynamics Applications Radar (CODAR). CODAR is a ground-based, high-frequency radar that uses back-scattered energy to determine various ocean surface parameters, such as surface currents and wave height, period, and direction. Data from CODAR were compared with those from more conventional wave measuring systems including both directional and nondirectional wave measuring buoys. Agreement between CODAR and buoy data was judged according to predetermined acceptance limits. The main objective of the program was to establish CODAR as an operational tool for routine use in the collection of coastal wave data. However, results from the comparisons with traditional systems were poor, and CODAR, as tested, cannot be recommended for operational use. GRA

N89-26283# Department of the Navy, Washington, DC.
SYSTEM AND METHOD FOR AIRBORNE GRAVITY MEASUREMENT USING INTERFEROMETRIC POSITIONING FROM SATELLITES Patent Application
John Brozena, inventor (to Navy) and Gerry Mader, inventor (to Navy) 30 Dec. 1988 39 p Filed 30 Dec. 1988
(AD-D014039; US-Patent-Appl-SN-292145) Avail: NTIS HC A03/MF A01 CSCL 08/5

A system and method for performing airborne gravity measurements using interferometric positioning from satellites is disclosed. The airborne gravity measurement system comprises: a plurality of satellites spaced apart in orbit about the earth for selectivity transmitting carrier waves; an Earth-based station which includes a first receiver responsive to the carrier waves from the satellites for developing a first set of carrier phase measurement signals, and a first data acquisition system for time-tagging and storing the first set of carrier phase measurement signals; an airborne vehicle which includes a gravimeter for producing gravimetry data representative of the vertical acceleration of the

airborne vehicle at each selected point, a second receiver for developing a second set of carrier phase measurement signals, and a second data acquisition system for time-tagging and storing the gravimetry data and the second set of carrier phase measurement signals: and a gravimeter processor responsive to the time-tagged gravimeter data and the time-tagged first and second sets of carrier phase measurement signals for determining the magnitude of the gravity in relation to the airborne vehicle.
GRA

N89-26284# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
SPECTRAL CHARACTERIZATION AND IDENTIFICATION OF AFFECTED AREAS OF EUCALYPTUS DYEBACK IN THE RIO DOCE VALLEY (SPEVRD) WITH EMPHASIS ON ORBITAL TM/LANDSAT DATA M.S. Thesis [CARACTERIZACAO ESPECTRAL E IDENTIFICACAO DE AREAS AFETADAS PELA SECA DE PONTEIROS DO EUCALIPTO DO VALE DO RIO DOCE (SPEVRD) COM ENFASE EMDADOS ORBITAIS TM/LANDSAT]
Ricardo Henrique SampaioSantiago Oct. 1988 98 p In PORTUGUESE; ENGLISH summary
(INPE-4713-TDL/344) Avail: NTIS HC A05/MF A01

A remote sensing methodology was applied to spectrally characterize eucalyptus dyeback in the Rio Doce Valley (SPEVRD), Minas Gerais State. Spectroradiometric data, 35 mm color and color infrared aerial photography and TM/LANDSAT data were used to that characterization. Significant spectral differences between healthy and damaged samples were verified through spectroradiometric analysis. Both color infrared aerial photographs allowed the identification of eucalyptus dyeback, however the latter presented the best performance. TM/LANDSAT data were submitted to different types of digital processing such as: suppression of atmospheric effets, contrast strech, band ratio and prinicpal component transformation. TM wave bands were also statistically analysed to define the best product to discriminate between heathly and damaged eucalyptus. The results showed the following decreasing performance for the individual bands: 4, 3, 1, 5, 2, 7. TM4/TM3 ratio however; proved to be better than the best individual TM Band. A qualitative analysis of PC2 showed that this product provided the best visual discrimination capability between healthy and damaged eucalyptus. The study led to the following conclusions: the methodology is suitable for eucalyptus dyeback characterization in flat terrain; results discouraged the application of this methodology in montaneous region. Author

N89-26285# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
AN EXPERT SYSTEM FOR SPECIFICATION OF SATELLITE IMAGE PRODUCTS
Edson Luiz FrancaSenne, Antonio Miguel VieiraMonteiro, Leonardo SantAnnaBins, Antonio Francisco, Jr., and Flavio Roberto DiasVelasco Dec. 1988 10 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote sensing, Natal, RN, 11-15 Oct. 1988
(INPE-4750-PRE/1423) Avail: NTIS HC A02/MF A01

To make effective use of satellite images, one must determine which image product to use, that is, which sensor, band, scale, presentation and dates are more appropriate. Also it is necessary to know how to proceed to extract desired information from the images and what are the limitations of this information. A prototype of an expert system is described which was designed to assist the user in specifying which image product to use to solve a specific Remote Sensing problem, given a set of available resources. The system is restricted to LANDSAT TM images.
Author

N89-26286 Technische Univ., Delft (Netherlands).
COMPUTER-ASSISTED CARTOGRAPHICAL THREE-DIMENSIONAL IMAGING TECHNIQUES Ph.D. Thesis
Menno-Jan Kraak 1988 186 p Original contains color illustrations
(ISBN-90-6275-463-5; ETN-89-94895) Copyright Avail: Delft Univ. Press, Stevinweg 1, 2628 CN Delft, Netherlands

Characteristics of three-dimensional maps were studied to determine whether three-dimensional maps produced by computer-assisted cartography give the map user a better understanding of the mapped phenomena. It is concluded that, with few exceptions, general cartographic theory can be applied to three-dimensional maps. In the cartographic communication process the spatial map images function at least as well as two-dimensional maps, provided they are kept relatively simple. For more complex maps a further comparison between two- and three-dimensional maps is necessary. Viewing the spatial map images in stereo results in a faster, but not necessarily better understanding of the map. ESA

N89-26287# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abteilung HF-Physik.
REFLECTION FROM LAYERED MEDIA WITH SPECIAL ATTENTION TO THE MICROWAVE REGION
Juergen Preissner Jan. 1989 52 p In GERMAN; ENGLISH summary
(DFVLR-Mitt-89-03; ISSN-0176-7739; ETN-89-94982) Avail: NTIS HC A04/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 19

The reflection at plane multilayered media is described and the mathematical formulation is given. A computer program was developed. Calculations show the dependence of the reflection on the layer configuration, layer thickness, incidence angle, and frequency. Examples for application (measurement of oil thickness and reflection reduction) are discussed. ESA

44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

N89-26288# Case Western Reserve Univ., Cleveland, OH. Case Western for Electrochemical Sciences.
ELECTROCHEMICAL CHARACTERISTICS OF ACID ELECTROLYTES FOR FUEL CELLS Final Report, 1 Aug. 1985 - 31 Dec. 1988
M. Razaq, A. Razaq, and E. Yeager 31 Jan. 1989 214 p Sponsored by ONR and NIH
(Contract GRI-5084-260-1108)
(PB89-178768; GRI-89/0025) Avail: NTIS HC A10/MF A01 CSCL 10A

Electrochemical characterization of a number of perfluorinated acids was carried out with the emphasis on the identification of alternate acids which may replace the presently used H3PO4 in the H2-O2 fuel cells. The kinetics of O2 reduction in the clean perfluorinated acids on smooth Pt and on high surface area Pt calalyzed electrodes (10 percent Pt on Vulcan XC-72) was found to be much faster than in phosphoric acid. The potential of the O2 cathode in the micro-fuel cell utilizating some of the new acids particularly, CF3PO(OH)2, (CF3SO2)2NH, (CF3SO2)2CH2, and (DF3S)2NHSO2CF2)2 is 40 percent 60 mV higher than H3PO4; over an order of magnitude and a factor of 5 to 6 respectively. The specific conductivities of the dilute perfluorinated acids are higher than phosphoric acid whereas the specific conductivities of the concentrated perfluorinated acids, particularly the imides, are lower than 85 percent phosphoric acid. A number of the perfluorinated acids used as minor additives to 85 percent H3PO4 were found to improve significantly the performance of the oxygen cathode. The approach of achieving higher performance for the phosphoric acid fuel cell is very promising but is contingent on

identifying surfactant-like additives with very low intrinsic vapor pressure and stability at elevated temperatures. GRA

N89-26289# Idaho Univ., Moscow. Dept. of Chemistry.
IMPROVED ACID ELECTROLYTES FOR FUEL CELLS Final Report, Jul. 1985 - Jan. 1989
Jeanne M. Shreeve Jan. 1989 38 p
(Contract GRI-5084-260-0986)
(PB89-173629; GRI-89/0026) Avail: NTIS HC A03/MF A01 CSCL 10A

A large number of new acids and their precursors were synthesized and characterized, including four monophosphonics (CF3)2CFP(O)(OH)2, H(CF2)2O(CF2)2P(O)(OH)2, H(CF2)4O-(CF2)2P(OH)2, and (HO)2P(O)(CF2)4O(CF2)2H; two monosulfonics CF3CF2O(CF2)2SO2OH:H20 and CF3(CF2)3O(CF2)-2SO2OH:H20; one disulfonic, HOSO2CF2CF2OCF2SO2OH; and three mixed phosphonic/sulfonics (HO)2P(O)CF2SO2OH, (HO)2P-(O)CFHSO2OH, and (HO)2P(O)(CF2)4O(CF2)2SO2OH. Two perfluoroalkyl phosphonic acids, the disulfonic acid and (HO)2P(O)-CF2SO3H were synthesized in larger quantities for further testing as electrolytes or additives in fuel cells. The acids with ether linkages appear to exhibit good water solubility and superior activity for oxygen reduction compared to phosphoric acid when used as additives. Author

N89-26290# Westinghouse Research and Development Center, Pittsburgh, PA.
SOLID OXIDE FUEL CELL TECHNOLOGY DEVELOPMENT Annual Report, 1 May 1987 - 30 Apr. 1988
E. R. Ray Dec. 1988 127 p
(Contract GRI-5086-294-1273)
(PB89-173652; Rept-1273-12; GRI-88/0275) Avail: NTIS HC A07/MF A01 CSCL 10A

The effort is focused on successfully operating a tubular solid oxide fuel cell (SOFC) generator directly on pipeline natural gas without external reforming. A materials test loop and a highly instrumented test facility were placed in operation. A 2000-hour single cell life test was successfully completed. Impregnation of both anode and module parts was demonstrated to minimize carbon deposition. Stable performance has been demonstrated in two 36-cell bundle tests. A 3kw module has been developed which can serve as the building block of larger modules. Studies have been performed on potential SOFC generator users' requirements and applications to confirm competitive potential in industrial and cogeneration applications. GRA

N89-26291*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE GaAs SOLAR CELLS WITH V-GROOVED EMITTERS
Sheila G. Bailey, N. Fatemi (Sverdrup Technology, Inc., Cleveland, OH.), D. M. Wilt, Geoffrey A. Landis, and R. D. Thomas 1989 6 p Presented at the European Space Power Conference, Madrid, Spain, 2-6 Oct. 1989; sponsored by the ESA
(NASA-TM-102104; E-4870; NAS 1.15:102104) Avail: NTIS HC A02/MF A01 CSCL 10A

Geometrically structured surfaces have become increasingly important to solar cell efficiency improvements and radiation tolerance. Gallium arsenide solar cells with a V-grooved front surface which demonstrate improved optical coupling and higher short-circuit current compared to planar cells were fabricated. GaAs homojunction cells were fabricated by organometallic chemical vapor deposition (OMCVD) on an n+ substrate. The V-grooves were formed on the surface with an anisotropic etch, and an n-type buffer and p-type emitter were grown by OMCVD, followed by ohmic contacts. Reflectivity measurements show significantly lower reflectance for the microgrooved cell compared to the planar structure. The short circuit current of the V-grooved solar cell is consistently higher than that of the planar controls. Author

N89-26292*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ON-ORBIT RESULTS OF THE LIPS 3/InP HOMOJUNCTION SOLAR CELL EXPERIMENT
David J. Brinker 1989 7 p Presented at the European Space Power Conference, Madrid, Spain, 2-6 Oct. 1989; sponsored by the ESA
(NASA-TM-102131; E-4921; NAS 1.15:102131) Avail: NTIS HC A02/MF A01 CSCL 10A

The flight performance of NASA Lewis Research Center's indium phosphide homojunction solar cell module on the LIPS 3 satellite is presented. A module of four n+p cells was fabricated and has been on-orbit on the LIPS 3 spacecraft since 1987. The experimental objective is the measurement of InP cell performance in the natural radiation environment of the 1100 kilometer altitude, 60 deg inclination, circular orbit. Flight data from the first year is near expected values, with no degradation in short-circuit current. The temperature dependence of current-voltage parameters is included along with the laboratory radiation tolerance studies necessary for normalization and analysis of the data. Details of the cell structure and flight module design are also discussed. Author

N89-26293# Astrosystems International, Inc., Newark, DE. AstroPower Div.
THE GaAsP TOP SOLAR CELLS FOR INCREASED SOLAR CONVERSION EFFICIENCY Final Report, Jun. 1985 - Sep. 1988
James B. McNeely, Gerald H. Negley, and Allen M. Barnett Jan. 1989 49 p
(Contract F33615-86-C-2605; AF Proj. 3005)
(AD-A206808; AFWAL-TR-88-2120) Avail: NTIS HC A03/MF A01 CSCL 10/2

The development of multijunction solar cells is the key to achieving large increases in solar power conversion efficiency over current state-of-the-art technology. In the optimal multijunction design, the top solar cell is the most critical since, by itself, it generates two-thirds of the total power generated by the solar cell stack. There are two viable technical approaches for the top solar cell for the mechanically-stacked tandem solar cell: GaAsP/GaP and AlGaAs/AlGaAs. Both top solar cell approaches have demonstrated good device properties. No other approach has made acceptable devices. GRA

45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

N89-26294# Federal Aviation Administration, Atlantic City, NJ.
ANALYSIS OF HELICOPTER ENVIRONMENTAL DATA: INDIANAPOLIS DOWNTOWN HELIPORT, WALL STREET HELIPORT. VOLUME 1: SUMMARY Technical Note for Period Ending May 1988
Rosanne M. Weiss, John G. Morrow, Donald Gallagher, Mark DiMeo, and Scott Erlichman Oct. 1988 61 p
(AD-A206708; DOT/FAA/CT-TN87/54-Vol-1) Avail: NTIS HC A04/MF A01 CSCL 01/5

During the summer of 1987 heliport environmental data were collected at the Indianapolis Downtown Heliport and at New York's Wall Street Heliport. The purpose of this data collection activity was to obtain measures of rotorwash in the heliport environment due to maneuvering helicopters, and to obtain pilot perceptions and observations concerning maneuvering and parking separation criteria. Ten wind vector transmitters were situated at various locations around the helicopter in order to gather information to describe the rotorwash induced wind speed and direction changes. Pilot interviews were also conducted at these heliports. Volume 1 of this report documents the results of this activity. It describes the data collection and analysis methodology and addresses technical as well as operational issues. It provides graphical descriptions of the heliport environment and of wind speed changes

due to rotorwash from maneuvering helicopters, along with analysis of pilot responses. The results of this study will be considered in future modifications of the Federal Aviation Administration Heliport Design Advisory Circular 150/390-2. GRA

46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

N89-26295# Royal Inst. of Tech., Stockholm (Sweden). Dept. of Plasma Physics.

ELECTRIC FIELDS IN THE MAGNETOSPHERE: A REVIEW

Carl-Gunne Faelthammar Oct. 1988 42 p Presented at the Workshop on Recent Results in Ionospheric and Magnetospheric Physics, Hobart, Tasmania, 5-9 Sep. 1988

(TRITA-EPP-88-12; ISSN-0348-7539) Avail: NTIS HC A03/MF A01

The satellites S3-3, GEOS-1, GEOS-2, ISEE-1 and Viking have extended direct measurements of electric fields to include the outer regions of the magnetosphere. The measurements confirm some of the theoretically expected properties of the electric fields. More importantly, they also reveal unexpected features and a high degree of complexity and variability. The existence of a magnetospheric dawn to dusk electric field has been confirmed in an average sense. However, the actual field exhibits large spatial and temporal variations, including strong fields of inductive origin. At the magnetopause, the average (dawn to dusk directed) tangential electric field component is typically obscured by irregular fluctuations of larger amplitude. The magnetic field aligned component of the electric field, which is of particular importance for ionosphere-magnetosphere coupling and for auroral acceleration is even now very difficult to measure directly. However, the data from electric field measurements provide further support for the conclusion, based on a variety of evidence, that a non-vanishing magnetic-field aligned electric field exists in the auroral acceleration region. Author

N89-26296*# Alabama Univ., Huntsville.

INTERPRETATION OF THE N2 LBH GLOW OBSERVED ON THE S3-4 SPACECRAFT

D. G. Torr and M. R. Torr (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) Jul. 1987 18 p Submitted for publication

(Contract NAS8-057)

(NASA-CR-185102; NAS 1.26:185102) Avail: NTIS HC A03/MF A01 CSCL 04A

Emissions in the vacuum ultraviolet Lyman-Birge-Hopfield (LBH) bands of N2 were observed at night from the S3-4 spacecraft and from the Space Shuttle. No atmospheric source of this emission was identified. Conway et al. have reported that the intensity of the S3-4 LBH emission varied as the cube power of the N2 or N2O concentration. A vehicle-atmosphere interaction was suggested as the source but it was found that the needed excitation cross section would have to be unacceptably large. Recent models of the gas concentration build-up around large space vehicles predict concentrations that may be consistent with the observe LBH intensity variation with altitude. The emission in the model is generated primarily by secondary collisional excitation by ambient N2 and/or O of desorbed metastable molecular constituents. A Chapman-like production function in the induced gaseous environment results in the observed cube power of the N2 concentration altitude variation. A cross section of approximately 2.5 x 10(-18) sq cm is required for excitation of desorbed metastable N2(A) to the N2 (a 1 Pi g) state to account for the observed intensities. Author

N89-26297# Aerospace Corp., El Segundo, CA. Space Sciences Lab.

ESTIMATION OF IONOSPHERIC ELECTRODYNAMIC PARAMETERS USING IONOSPHERIC CONDUCTANCE DEDUCED FROM BREMSSTRAHLUNG X-RAY IMAGE DATA

B.-H. Ahn, H. W. Kroehl, Y. Kamide (Kyoto Sangyo Univ., Japan), and D. J. Gorney 16 Feb. 1989 56 p

(Contract F04701-85-C-0086)

(AD-A206457; TR-0088(3940-06)-4; SD-TR-89-08) Avail: NTIS HC A04/MF A01 CSCL 04/1

Various ionospheric electrodynamic parameters are calculated by using ground magnetic records from a total of 88 stations in the northern hemisphere. For this purpose, an instantaneous conductance distribution deduced from the DMSP-F6 bremsstrahlung x-ray image data is utilized. It is a unique opportunity to examine some of the inherent ambiguity in the magnetogram-inversion technique based on a statistically-derived conductance model. Important conclusions are: (1) The pole-ward portion of the westward electrojet in the morning sector is dominated by electric field, while its equatorward portion is dominated by the ionospheric conductance. (2) During a quiet or moderately disturbed period, the major electric potential pattern is roughly circumscribed by the auroral zone conductance belt. (3) The global pattern of the equivalent current system resembles the electrical potential distribution. (4) The electric potential distribution consists generally of a smooth and well-defined two-cell convection pattern without any significantly localized structure. (5) A sunward convection flow is clearly identified over the polar cap region. (6) During strongly northward IMF periods, significant currents and joule dissipation are observed in the polar cap region, indicating that the magnetosphere is far from its ground state. (7) The regions of intense joule heating are generally confined to relatively narrow belts. (8) The Region 2 upward current in the morning hemisphere is roughly collocated with the enhanced conductance region. GRA

N89-26298# National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.

RASS (RADIO ACOUSTIC SOUNDING SYSTEM) TEMPERATURE SOUNDING TECHNIQUES

R. G. Strauch, K. P. Moran, P. T. May (Colorado Univ., Boulder.), A. J. Bedard, and W. L. Ecklund Dec. 1988 18 p

(Grant MIPR-ASL-86-8004)

(PB89-159677; NOAA-TM-ERL-WPL-158) Avail: NTIS HC A03/MF A01 CSCL 04A

The Radio Acoustic Sounding System (RASS) Technique for measuring temperature profiles in the lower troposphere was revived in the United States (U.S.) during the past year by the Aeronomy Laboratory (AL) and Wave Propagation Laboratory (WPL) of the National Oceanic and Atmospheric Administration. The implementation of RASS on wind profiler radars for these preliminiary experiments is described, results are summarized for early experiments that show that RASS temperature profiles can be measured to several kilometers above the surface, and the addition of RASS to operational wind profilers is examined. GRA

N89-26299# Swedish Defence Research Establishment, Umea.

APIUTV: SOFTWARE FOR CALCULATION AND PRESENTATION OF MEASURED DATA FROM API: USERS GUIDE AND SOFTWARE SOLUTION

Lena Melin Jan. 1989 36 p In SWEDISH; ENGLISH summary Sponsored by the Swedish State Power Board

(FOA-E-40041; ISSN-0281-9945; ETN-89-94543) Avail: NTIS HC A03/MF A01; Swedish Defence Research Establishment, S-901 82 Umea, Sweden, 50 Swedish crowns

A periodic automatic data transmission, using the normal telephone, from villages situated near a nuclear power plant to a computer is described. Each sort of data from the different points is called API (automatic position determined indication). Even mobile API can be used. The data is stored in files, one for each API, during 1 month. Plotted charts can be seen on the terminal or are presented as maps for all API together. Data for one separate API are shown on a histogram. All radiation values are expressed

in micro Sievert per hour or day. Information about atmospheric circulation (wind): height above sea level, velocity, and direction are recorded. ESA

N89-26300*# Johns Hopkins Univ., Baltimore, MD. Dept. of Earth and Planetary Sciences.

THE DELINEATION AND INTERPRETATION OF THE EARTH'S GRAVITY FIELD Annual Progress Report, 1 Jun. 1988 - 31 May 1989

Bruce D. Marsh May 1989 24 p
(Grant NAG5-32)
(NASA-CR-185333; NAS 1.26:185333) Avail: NTIS HC A03/MF A01 CSCL 08G

In an attempt to understand the mechanical interaction of a growing lithosphere containing fracture zones with small and large scale mantle convection, which gives rise to geoid anomalies in oceanic regions, a series of fluid dynamical experiments is in progress to investigate: (1) the influence of lithosphere structure, fluid depth and viscosity field on the onset, scale, and evolution of sublithospheric convection; (2) the role of this convection in determining the rate of growth of lithosphere, especially in light of the flattening of the lithosphere bathymetry and heat flow at late times; and (3) combining the results of both numerical and laboratory experiments to decide the dominate factors in producing geoid anomalies in oceanic regions through the thermo-mechanical interaction of the lithosphere and subjacent mantle. The clear existence of small scale convection associated with a downward propagating solidification front (i.e., the lithosphere) and a larger scale flow associated with a discontinuous upward heat flux (i.e., a fracture zone) has been shown. The flows exist simultaneously and each may have a significant role in deciding the thermal evolution of the lithosphere and in understanding the relation of shallow mantle convection to deep mantle convection. This overall process is reflected in the geoid, gravity, and topographic anomalies in the north-central Pacific. These highly correlated fields of intermediate wavelength (approx. 200 to 2000 km) show isostatic compensation by a thin lithosphere for shorter (less than or equal to approx. 500 km), but not the longer, wavelengths. The ultimate, dynamic origin of this class of anomalies is being investigated.
Author

N89-26301# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.

GROUND DEPOSITION OF LIQUID DROPLETS RELEASED FROM A POINT SOURCE IN THE ATMOSPHERIC SURFACE LAYER Ph.D. Thesis

Bernard Panneton May 1989 209 p
(UTIAS-331; ISSN-0082-5255) Avail: NTIS HC A10/MF A01

A series of field experiments is presented in which the ground deposition of liquid droplets, 120 and 150 micrometers in diameter, released from a point source at 7 meters above the ground level, was measured. A detailed description of the experimental technique is provided, and the results are presented and compared to the predictions of a few models. A new rotating droplet generator is described. Droplets are produced by the forced breakup of capillary liquid jets and droplet coalescence is inhibited by the rotational motion of the spray head. A system for analyzing spray samples was developed. This is a specialized image analysis system based on an electronic digitizing camera which measures the area and perimeter of stains left by dyed droplets collected on Kromekote cards. A complete set of meteorological data supports the ground-deposition data. The turbulent air velocities at two levels above the ground and the temperature of the air at one level were measured with one sonic anemometer and a sonic anemometer-thermometer. The vertical heat and momentum fluxes were estimated using the eddy-correlation technique. The two-dimensional deposition patterns are presented in the form of plots of contours of constant density, normalized arcwise distributions and crosswind integrated distributions. Models of the crosswind integrated deposit from Godson, Csanady, Walker, Bache and Sayer, and Wilson et al., are evaluated. The results indicate that the Wilson et al random walk model is adequate for predicting the ground deposition of the 150 micrometer droplets.
Author

N89-26302# California Inst. of Tech., Pasadena. Div. of Geological and Planetary Sciences.

IDEAL Fe-FeS, Fe-FeO PHASE RELATIONS AND THE EARTH'S CORE

Bob Svendsen, William W. Anderson, Thomas J. Ahrens, and Jay D. Bass (Illinois Univ., Urbana.) 1987 82 p Submitted for publication
Avail: NTIS HC A05/MF A01 CSCL 08G

Liquid-state and solid-state models fit the melting data for Fe, FeS and FeO, and provide constraints for calculating ideal phase relations in Fe-FeS and Fe-FeO systems in the pressure range corresponding to the earth's outer core. The liquid-state model fit to the Fe melting data of Williams and Jeanloz (1986) places constraints on the temperature and other properties along the liquidus above the range of their data. The temperature along the best-fit Fe liquidus is 5000 K at 136 GPa and 7250 K at 330 GPa, which is somewhat lower than that implied by the Hugoniot results (similar to 7800 K). This discrepancy may be due to the reshock effect discussed above, or some inaccuracy in the extrapolation, presuming the Hugoniot results represent the equilibrium melting behavior of Fe. Calculations for the equilibrium thermodynamic properties of solid and liquid Fe along the coincident solidus and liquidus imply that the entropy of melting for Fe is approximately independent of pressure at a value of approximately R (where R is Ryberg's constant), while the change in the molar heat capacity across the transition increases with pressure from approximately 0.5 R to 4 R between standard pressure and 330 GPa. Existing constraints were used to construct ideal-mixing phase diagrams for Fe-FeS and Fe-FeO systems at outer core pressures, assuming that Fe and FeS, or Fe and FeO, respectively, are the solid phases in equilibrium with the liquid Fe-FeS or Fe-FeO mixtures, respectively. Author

N89-26303*# California Inst. of Tech., Pasadena. Div. of Geological and Planetary Sciences.

SPALL VELOCITY MEASUREMENTS FROM LABORATORY IMPACT CRATERS

Carol A. Polanskey and Thomas J. Ahrens [1986] 44 p Submitted for publication
(Grant NGL-05-002-105)
(NASA-CR-185364; NAS 1.26:185364) Avail: NTIS HC A03/MF A01 CSCL 08G

Spall velocities were measured for a series of impacts into San Marcos gabbro. Impact velocities ranged from 1 to 6.5 km/sec. Projectiles varied in material and size with a maximum mass of 4g for a lead bullet to a minimum of 0.04 g for an aluminum sphere. The spall velocities were calculated both from measurements taken from films of the events and from estimates based on range measurements of the spall fragments. The maximum spall velocity observed was 27 m/sec, or 0.5 percent of the impact velocity. The measured spall velocities were within the range predicted by the Melosh (1984) spallation model for the given experimental parameters. The compatability between the Melosh model for large planetary impacts and the results of these small scale experiments is considered in detail. The targets were also bisected to observe the internal fractures. A series of fractures were observed whose location coincided with the boundary of the theoretical near surface zone predicted by Melosh. Above this boundary the target material should receive reduced levels of compressive stress as compared to the more highly shocked region below. Author

N89-26304*# Oxford Univ. (England). Dept. of Atmospheric Physics.

NIMBUS-7 STRATOSPHERIC AND MESOSPHERIC SOUNDER (SAMS) EXPERIMENT DATA USER'S GUIDE

F. W. Taylor, C. D. Rodgers, S. T. Nutter, and N. Oslik (ST Systems Corp., Lanham, MD.) Washington May 1989 149 p
(Contract NAS5-28063)

(NASA-RP-1221; NAS 1.61:1221; Rept-89B00074) Avail: NTIS HC A07/MF A01 CSCL 08G

The Stratospheric and Mesospheric Sounder (SAMS) aboard Nimbus-7 observes infrared radiation from the atmospheric limb. Global upper atmosphere temperature profiles and vertical concentrations of H2O, NO, N2O, CH4 and CO2 are derived from these measurements. The status of all channels was carefully monitored. Temperature and composition were retrieved from the measurements by linearizing the direct equation about an a priori profile and using an optimum statistical estimator to find the most likely solution. The derived temperature and composition profiles are archived on two tape products whose file structure and record formats are described in detail. The gridded retrieved temperature tape (GRID-T) contains daily day and night average temperatures at 62 pressure levels in a 2.5 degree latitude by 10 degree longitude grid extending from 67.5 degrees N to 50 degrees S. The zonal mean methane and nitrous oxide composition tape (ZMT-G) contains zonal mean day and night average CH4 and N2O mixing ratios at 31 pressure levels for 2.5 degrees latitude zones extending from 67.5 degrees N to 50 degrees S. Author

N89-26305*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

AN IMPROVED ERROR ASSESSMENT FOR THE GEM-T1 GRAVITATIONAL MODEL

F. J. Lerch, J. G. Marsh, S. M. Klosko, E. C. Pavlis, G. B. Patel, D. S. Chinn, and C. A. Wagner (National Geodetic Survey, Rockville, MD.) Nov. 1988 129 p

(NASA-TM-100713; Rept-88B0021; NAS 1.15:100713) Avail: NTIS HC A07/MF A01 CSCL 08G

Several tests were designed to determine the correct error variances for the Goddard Earth Model (GEM)-T1 gravitational solution which was derived exclusively from satellite tracking data. The basic method employs both wholly independent and dependent subset data solutions and produces a full field coefficient estimate of the model uncertainties. The GEM-T1 errors were further analyzed using a method based upon eigenvalue-eigenvector analysis which calibrates the entire covariance matrix. Dependent satellite and independent altimetric and surface gravity data sets, as well as independent satellite deep resonance information, confirm essentially the same error assessment. These calibrations (utilizing each of the major data subsets within the solution) yield very stable calibration factors which vary by approximately 10 percent over the range of tests employed. Measurements of gravity anomalies obtained from altimetry were also used directly as observations to show that GEM-T1 is calibrated. The mathematical representation of the covariance error in the presence of unmodeled systematic error effects in the data is analyzed and an optimum weighting technique is developed for these conditions. This technique yields an internal self-calibration of the error model, a process which GEM-T1 is shown to approximate. Author

N89-26306# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

THE SPECTRAL ANALYSIS APPROACH TO MIDDLE ATMOSPHERIC MODELING

Carlos Jose Zamlutti Nov. 1988 11 p Presented at the 27th COSPAR, Helsinki, Finland, Aug. 1988

(Contract FINEP-537/CT)
(INPE-4726-PRE/1403) Avail: NTIS HC A03/MF A01

The theoretical aspects of using spectral analysis in middle atmosphere modelling are discussed. The starting point is the hydrodynamic equations on which a wavelike solution is imposed. This procedure allows researchers to identify: (1) a dispersion relation; (2) excitation and damping mechanism; (3) mutual coupling between each pair of modes. Next, the problem of choosing appropriate boundary conditions is discussed. Finally, researchers comment on the accuracy aspects of this type of modelling. Author

N89-26307# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

ROCKET BORNE MEASUREMENTS OF EQUATORIAL IONOSPHERIC ELECTRON DENSITIES AND THEIR COMPARISON WITH IRI-10 PREDICTIONS

M. A. Abdu, P. Muralikrishna, E. R. dePaula, and I. J. Kantor Sep. 1988 16 p Presented at the 27th COSPAR Plenary Meeting, Espoo, Finland, 18-29 Jul. 1988

(Contract FINEP-537/CT)
(INPE-4702-PRE/1387) Avail: NTIS HC A03/MF A01

Electron density height profiles of the equatorial ionosphere measured by rocket-borne probes are compared with their predictions from IRI-10. Three experiments were conducted using High Frequency Capacitance probes carried on board SONDA 3 rockets that were launched off the coast of Natal (36 deg W, 12 deg S), Brazil. Results from two of the experiments, one daytime, and one nighttime, represented quiet ionospheric conditions whereas the third experiment was launched into a nighttime ionosphere that was disturbed by a developing plasma bubble event. Degrees of agreement between the experimental results and the IRI predictions for the quiet day and night densities varied with height. These comparative studies are complemented by including the electron densities obtained from the semi-empirical Low Latitude Ionospheric Model (SLIM) as appropriate for the rocket flight conditions. A detailed discussion is carried out of the results of these comparative studies. Author

N89-26308*# Oxford Univ. (England). Dept. of Atmospheric, Oceanic and Planetary Physics.

OSCILLATIONS IN D-REGION ABSORPTION AT PERIODS OF ONE TO TWO MONTHS

J. L. Stanford and R. C. Saksena (National Physical Lab., New Delhi, India) 1989 14 p

(Grants NAG5-1060; NSF ATM-87-22703)
(NASA-CR-184684; NAS 1.26:184684) Avail: NTIS HC A03/MF A01 CSCL 04A

One to two month oscillations in D-region absorption are found in seven years of daily f-min data from low latitude stations at Singapore (1N, 104E) and Rarotonga (21S, 160W). Coherency (cross-spectral) analyses reveal that solar flux variations account for much of the f-min variance at these periods. Over the range of periods from 10 to 200 days, statistically significant linear correlation is found between the f-min time series and contemporaneous 10.7 cm solar flux mearurements at periods of 16 to 19 days, the 26 to 29 day solar rotation band, and a broad band covering 43 to 80 day periods. Author

N89-26309*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

RADIAL DEFORMATION OF THE EARTH BY OCEANIC TIDAL LOADING

R. D. Ray (ST Systems Corp., Lanham, MD.) and B. V. Sanchez Jul. 1989 52 p

(NASA-TM-100743; Rept-89-154; NAS 1.15:100743) Avail: NTIS HC A04/MF A01 CSCL 08G

A high-degree spherical harmonic series is used to compute the radial deformation of the Earth by oceanic tidal loading. By exploiting fast numerical transforms, this approach is found to be much more efficient, but no less accurate, than the traditional Green's function approach. The method is used to derive an atlas of load tide maps for 10 constitutents of the NSWC ocean tide model. Author

N89-26310*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

ANALYSIS OF NOVA-1 DOPPLER DATA

T. L. Felsentreger and R. G. Williamson (ST Systems Corp., Lanham, MD.) Jul. 1989 19 p

(NASA-TM-100736; Rept-89B00157; NAS 1.15:100736) Avail: NTIS HC A03/MF A01 CSCL 08G

The intent is to prepare a set of Doppler tracking data for the NOVA-1 Satellite to be included in a data base of satellite tracking data. This data base is to be used in a solution for the gravity

field of the Earth. This new gravity field model is needed so that the orbit of the proposed TOPEX (Ocean TOPography EXperiment) satellite can be determined accurately enough for the satellite's missions to be accomplished. Author

N89-26311# Northeast Radio Observatory Corp., Westford, Mass. Haystack Observatory.
MULTI-INSTRUMENT STUDIES OF THE AURORAL IONOSPHERE Final Report, 1 Nov. 1985 - 31 Oct. 1988
J. C. Foster 24 Mar. 1989 18 p
(Grant AF-AFOSR-0023-86; AF Proj. 2310)
(AD-A206733; AFOSR-89-0399TR) Avail: NTIS HC A03/MF A01 CSCL 04/1

New data collection modes and analysis techniques were developed which provide good time and spatial coverage and empirical models of the high latitude ionosphere have been developed and tested. (1) The first three-radar azimuth scanning experiment was performed combining observations from Millstone Hill, Sondrestrom, and EISCAT to produce maps of the convection electric field at high latitudes at 30 minute intervals throughout an interval of increasing disturbance. (2) Empirical models of the ionospheric convection electric field were developed from an extensive radar data base. (3) Quantitative models have been developed describing the distribution of the field-aligned currents which link the ionosphere and magnetosphere at high-latitudes. (4) A test of the local midnight-sector differences in the ionospheric convection models based on incoherent scatter radar data and those based on satellite observations was completed. (5) A new class of intense radar backscatter from the topside F region was identified as produced by parallel current-induced enhancement of the acoustic line. (6) The general characteristics of coherent radar backscatter from E region irregularities as observed with the Millstone Hill UHF radar was the subject of an intensive study. GRA

N89-26312# Air Force Geophysics Lab., Hanscom AFB, MA. Optical Physics Div.
ATMOSPHERIC AEROSOL SCATTERING BACKGROUND OBSERVATIONS Interim Scientific Report
Frank W. Gibson 14 Jun. 1988 139 p
(AF Proj. 7670)
(AD-A206752; AFGL-TR-88-0146; AFGL-ERP-1006) Avail: NTIS HC A07/MF A01 CSCL 17/5

Optical scattering, under very clear atmospheric conditions, was measured in situ and analyzed. The experiments were made with a large balloonborne nephelometer launched from Holloman AFB, New Mexico and flown to 26 km altitude. Profiles of angular scattering and polarization properties of atmospheric aerosols show contrast with aerosol particles encountered in the troposphere and stratosphere. The results are compared with those obtained using particle counters under similar atmospheric conditions. GRA

N89-26313# Naval Submarine Medical Research Lab., Groton, CT.
UPWARD EXCURSION LIMITS FROM AIR SATURATION AT 5 ATA (ATMOSPHERES ABSOLUTE) Interim Report, Sep. 1984 - Jun. 1987
James W. Parker 19 Jan. 1989 17 p
(AD-A206774; NSMRL-1127) Avail: NTIS HC A03/MF A01 CSCL 13/10

Present USN submarine rescue capability makes a prolonged exposure of the submarine crew to hyperbaric air a distinct possibility. The exposure may be to pressures as great as 5 atmospheres absolute (ATA), and for periods of time of up to 72 hours. A series of experimental dives were conducted to establish the safe, upward excursion from 5 ATA (132 FSWG); that is, the maximum, immediate reduction in pressure which these individuals can safely tolerate. This specifies the required pressure in the compartment of a mother submarine to which the rescued personnel would be transferred. In order to minimize the effects of pulmonary oxygen toxicity, the limits first were established using a nitrox equivalent of air at 5 ATA. The upward limit from 4.36 ATA (111 FSWG) was found to be 2.97 ATA (65 FSWG). Once this limit had been set, a series of dives were conducted to test this up limit from standard air at 5 ATA. GRA

N89-26314# SRI International Corp., Menlo Park, CA.
GROUND-BASED MEASUREMENTS OF JOULE HEATING RATES
O. DeLa Beaujardiere, R. Johnson, and V. B. Wickwar 3 Apr. 1989 23 p
(Contract F19628-87-K-0006)
(AD-A206816; AFGL-TR-89-0091; SR-1) Avail: NTIS HC A03/MF A01 CSCL 04/1

Joule heating in the upper atmosphere is the most important energy dissipation process between the magnetosphere and the ionosphere. In this paper we examine the various terms in the equation that governs Joule heating: (1) the ionospheric electric field seasonal dependence is examined. It is found that the shape of the ionospheric plasma convection cells, and the latitude of the reversal from sunward to antisunward convection, are seasonally dependent. Statistical averages of the square of the ion velocity show a maximum in fall, and a minimum in summer; (2) Pedersen conductivities at F region altitudes are examined using Chatanika and Sondrestrom radar data. It is shown that during solar minimum conditions, the F region contributes less than 20 pct to the total height integrated Pedersen conductivity sigma p. In contrast, during solar maximum conditions the contribution to sigma from solar produced F-region ionization can be 60 pct; and (3) the importance of the neutral wind term in Joule heating calculations is illustrated using a specific example. The Joule heating calculated by including the neutral wind term is 2 to 4 times smaller than that calculated without the neutral wind. But the reverse can also be true, as shown during a period when the neutral wind played the role of a dynamo in the ionosphere/magnetosphere current. GRA

N89-26315# Texas Univ. at Dallas, Richardson. Center for Space Sciences.
ELECTRODYNAMICS OF THE HIGH LATITUDE IONOSPHERE
R. A. Heelis Nov. 1988 17 p
(Contract F19628-86-K-0042)
(AD-A206819; AFGL-TR-88-0324; SR-1) Avail: NTIS HC A03/MF A01 CSCL 04/1

A broad range of scientific investigations ranging from the development of large scale models of ionospheric convection to small scale plasma flows associated with polar cap arcs is described. It is shown that during times of northward IMF, coherent mesoscale convection features can frequently be identified at high latitudes. We now have the ability to quite accurately reproduce the convective features of the plasma at high latitudes during periods of southward IMF. Advance in our understanding of electric field coupling in plasma structures and the differences in local and height integrated Joule heating rates are also described. The importance of the bottomside F-region concentration in determining the effectiveness of electrical coupling is emphasized. GRA

N89-26316# Boston Coll., Chestnut Hill, MA.
MODEL STUDIES OF THE POLAR IONOSPHERE Final Report, 28 Aug. 1985 - 27 Nov. 1988
Robert E. Sheehan 21 Nov. 1988 88 p
(Contract F19628-85-K-0051)
(AD-A206821; AFGL-TR-88-0325) Avail: NTIS HC A05/MF A01 CSCL 04/1

This report presents modifications and additions to an ionospheric chemistry computer program that models the high latitude-polar cap ionosphere (1-dimensional along a magnetic field line; 100 to 600 km altitude). Interest centers on effects of soft (1 kev) electron fluxes typically observed precipitating into the polar cap ionosphere. Major changes involved incorporating an existing O + diffusion code with the Strickland local (E region) ionospheric chemistry code and the addition of electron and ion temperature calculations based on the diffusion code. Also included are calculations of Hall and Pedersen electric conductivities and a separate program that determines electric currents in the

ionosphere based on the model result; these were used in conjunction with measurements from the PIIE rocket campaign in Feb 1985. Some details of the numerical methods used in the various calculations are given, as well as an overview of the programming logic and a step-by-step description of program execution. The Strickland flux transport program that calculates production rates input to the chemistry model remains essentially unchanged but, a new parameterization scheme was developed that could have applications to global problems requiring a large number of flux calculations. GRA

N89-26317# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
COMPUTER APPLICATIONS IN GEOTECHNICAL ENGINEERING (CAGE) AND GEOTECHNICAL ASPECTS OF THE COMPUTER-AIDED STRUCTURAL ENGINEERING (G-CASE) PROJECTS. USER'S GUIDE. UTEXAS2 SLOPE-STABILITY PACKAGE. VOLUME 2: THEORY Final Report
Earl V. Edris, Jr. and Stephen G. Wright Feb. 1989 67 p (AD-A207044; WES/IR/GL-87-1-Vol-2) Avail: NTIS HC A04/MF A01 CSCL 12/5

This report describes the theory of a two-dimensional slope-stability analysis and covers the mechanics of limit-equilibrium procedures that utilize the wedge and slices methods. The mechanics of the four different procedures contained in the computer program UTEXAS2 (University of Texas Analysis of Slopes - version 2) are discussed as well as sources of potential errors. The limit-equilibrium equations and the calculation procedures used in the program are described in an appendix. GRA

N89-26318 Forschungsinstitut der Deutschen Bundespost, Darmstadt (Germany, F.R.).
A SIMPLE METHOD OF ESTIMATING THE IONOSPHERIC PARAMETERS FOF2 AND M (3000) WITH THE AID OF A HOME COMPUTER
Thomas Damboldt and Peter Suessmann Dec. 1988 13 p (FI-445-TB-25-E; ETN-89-94599) Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

A self-contained method for estimating the critical frequency and the height of the ionospheric reflecting layer was implemented in the computer program FTZMUF2, writen in BASIC. Including the accompanying table FTZMUF2.DAT the program only requires 8.7 kByte of memory and is therefore particularly suitable for use on small computers. The accuracy of the method was tested against the CCIR-Atlas (Report 340) for MUF(3000). An average difference of less than 0.1 MHz and a standard deviation of 2.3 MHz are obtained. A diskette (5 1/4 in., 360k, MS-DOS) with the source code, the data file, and the compiled programs is available from the authors upon request. ESA

N89-26345*# Desert Research Inst., Reno, NV.
DISTRIBUTION OF DESERT VARNISH IN ARIZONA Abstract Only
Christopher D. Elvidge *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 19 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 08G

N89-26371*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE ANTARCTIC DRY VALLEY LAKES: RELEVANCE TO MARS Abstract Only
R. A. Wharton, Jr., Christopher P. McKay, Rocco L. Mancinelli, G. D. Clow, and G. M. Simmons, Jr. (Virginia Polytechnic Inst., Blacksburg.) *In its* Exobiology and Future Mars Missions Mar. 1989 p 62 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 08G

47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

N89-26319# Colorado State Univ., Fort Collins. Dept. of Atmospheric Science.
FORECAST OF ATLANTIC SEASONAL HURRICANE ACTIVITY FOR 1988
William M. Gray 28 Jul. 1988 36 p Sponsored in part by NSF
Avail: NTIS HC A03/MF A01

An updated forecast is presented of the amount of seasonal hurricane and tropical storm activity which can be expected to occur in the Atlantic basin, Caribbean, and Gulf of Mexico region in 1988. This updated forecast is issued just before the start of the most active part of the hurricane season. The author's previous forecast for 1988 was issued on 1 June 1988 (Gray, 1988) and called for 7 hurricanes (1 above the average of the 1947-86 period), 11 named tropical storms (1 above the last 40-year average), and 30 hurricane days (5 above average), and a Hurricane Destruction Potential (HDP) of 75 (1 above last 40 year average). This updated forecast is based on the earlier forecast and more recent June and July meteorological data. This revised forecast is considered to be more reliable than the forecast issued at the end of May. Statistical information received as of 28 July 1987 indicates that the hurricane and tropical storm activity for 1988 can be expected to be as anticipated in late May. No update forecast alteration needs to be made. This means that the 1988 Atlantic hurricane season will likely be an above average season by the standards of the last 18 years and particularly so as regards to the hurricane activity of the last 6 seasons which has been very suppressed except for 1985. Intense hurricane activity during 1947 to 1969 was significantly higher than it has been since 1970. This season should likely have only slightly higher hurricane activity in comparison to the average conditions of the last 40 years, however. The probability is also high that this season will have a few more intense hurricanes than have occurred during the last few seasons. The Hurricane Destruction Potential (or HDP) of hurricanes in 1988 should be higher than in any previous season since 1981 except for the active season of 1985. Author

N89-26320# National Oceanic and Atmospheric Administration, Washington, DC. Satellite Applications Lab.
A DECISION TREE APPROACH TO CLEAR AIR TURBULENCE ANALYSIS USING SATELLITE AND UPPER AIR DATA
Gary Ellrod Jan. 1989 26 p
(NOAA-TM-NESDIS-23) Avail: NTIS HC A03/MF A01

A decision tree logic diagram is described which is designed to assist aviation forecasters or flight briefers in the analysis and short range prediction of Clear Air Turbulence (CAT). The decision tree uses satellite imagery and, to a lesser extent, upper air data at standard pressure levels. The levels of confidence are stated for each solution. The primary turbulence signatures as seen in satellite imagery are described and examples of each are shown. Author

N89-26321# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
DUAL-BEAM AUTOCORRELATION BASED ON WIND ESTIMATES FROM AIRPORT SURVEILLANCE RADAR SIGNALS
Mark E. Weber 21 Jun. 1989 51 p Original contains color illustrations
(Contracts F19628-85-C-0002; DTFA-01L-83-4-10579)
(ATC-167; DOT/FAA/PS-89/5) Avail: NTIS HC A04/MF A01

An efficient, autocorrelation based algorithm for estimating low altitude radial winds using signals from the two receiving beams of an airport surveillance radar (ASR) is described. The approach seeks to achieve the accuracy demonstrated previously for spectral domain dual beam velocity estimators with significantly reduced computational requirements. Fundamental to the technique is the assumption that the power spectrum measured with an airport surveillance radar's broad elevation beam can be fitted by a two component Gaussian model. The parameters of this model are

estimated using measured low-order autocorrelation lags from the low and high beam received signals. The desired near surface radial velocity estimate is obtained directly as one of these parameters - the center frequency of the low altitude Gaussian spectrum component. Simulated data and field measurements from Lincoln Laboratory's experimental ASR-8 in Huntsville, Alabama were used to evaluate the accuracy of the autocorrelation based velocity estimates. Monte Carlo simulations indicate that biases relative to the near surface outflow velocity in a microburst would be less than 2.5 m/s unless the microburst were distant (range greater than 12 km) or very shallow (depth of maximum wind speed layer less than 50 m). Estimate standard deviations averaged 0.5 m/s after the spatial filtering employed in the processing sequence. The algorithm's velocity estimate accuracy was sufficient to allow for automatic detection of measured microbursts during 1988 with a detection probability exceeding 0.9 and a false alarm probability less than 0.05. Our analysis indicates that the dual-beam autocorrelation based velocity estimator should support ASR wind shear detection at approximately the same level of confidence as the low-high beam spectral differencing algorithm evaluated by Weber and Noyes (1988). Author

N89-26322# Naval Postgraduate School, Monterey, CA.
SATELLITE PRECIPITATION ANALYSIS FOR A DEVELOPING NORTH PACIFIC OCEAN CYCLONE M.S. Thesis
Timothy F. Sheridan Dec. 1988 82 p
(AD-A206600) Avail: NTIS HC A05/MF A01 CSCL 04/2

Three satellite-based precipitation techniques are used to analyze the atmospheric precipitation pattern associated with a developing winter cyclone over the eastern North Pacific Ocean. A visible/infrared technique, developed by the Naval Postgraduate School (NPS), uses cloud-top temperature and albedo thresholds to produce a rain estimate. A microwave method, based on an algorithm made by the Hughes Aircraft Company (HAC), retrieves rain rate estimates based on both the thermal emission at 19 GHz and the scattering by precipitation-size ice at 37 GHz. Another microwave technique identifies rain coverage based solely on the high sensitivity of 85 GHz channels to ice scattering above the freezing level. A polarization corrected temperature (PCT) is formulated to isolate the 85 GHz precipitation effect. A subjective evaluation and comparison of the rain estimations are performed. The NPS technique produces representative results within the warm front, but appears to underestimate potential rain associated with the cold front. The HAC retrieval provides a synoptically realistic analysis of the cyclone's rain pattern, but does not resolve the potential precipitation within the isolated, convective clouds behind the cyclone. The PCT method gives a representative coverage of the convective activity within the cyclone and its surrounding area, but does not depict the potential rain areas associated with stratiform clouds. GRA

N89-26323# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
SELECTED WIND SHEAR EVENTS OBSERVED DURING THE 1987 EVALUATION OF ENHANCEMENTS TO THE FAA (FEDERAL AVIATION ADMINISTRATION) LOW LEVEL WIND SHEAR ALERT SYSTEM AT STAPLETON INTERNATIONAL AIRPORT
Michael F. Donovan and Marilyn M. Wolfson 15 Feb. 1989 118 p
(Contracts DTFA01-80-Y-10546; F19628-85-C-0002)
(AD-A206711; ATC-158; DOT/FAA/PS-88/9) Avail: NTIS HC A06/MF A01 CSCL 04/2

The FAA Technical Center (FAATC) conducted a test of the enhancements to the FAA Low Level Wind Shear Alert System (LLWAS) at Denver Stapleton International Airport from 3 Aug. to 4 Sep. 1987. Upon completion of the test, the performance of the LLWAS during selected microburst and gust front test cases was investigated in detail. Additional sources of true wind shear information were sought to help evaluate the performance of the LLWAS. In support of these efforts, Lincoln Laboratory supplied complete data sets, including single Doppler radar data from the Lincoln network of 30 automatic weather stations in the vicinity of Stapleton, and LLWAS data to the FAATC. This report summarizes salient features for a number of FAATC selected wind shear events which occurred during the evaluation of the enhanced LLWAS, and documents the data that Lincoln Laboratory has provided to the FAA as part of its project responsibilities. GRA

N89-26324# Washington Univ., Seattle. Applied Physics Lab.
SURFACE METEOROLOGY DURING OCEAN STORMS FIELD PROGRAM Technical Report, Aug. 1987 - Apr. 1988
Ronald W. Lindsay Oct. 1988 167 p
(Contract N00014-87-K-0004)
(AD-A206856; AD-E501080; APL-UW-TR8823) Avail: NTIS HC A08/MF A01 CSCL 04/2

A summary of the meteorological conditions in the Gulf of Alaska during the Ocean Storms experiment is presented along with a data set of the surface meteorological observations by ships of opportunity and National Data Buoy Center buoys. An optimal interpolation procedure is described and used with the surface observations to interpolate air pressure, wind speed and direction, air temperature, air-sea temperature difference, and dew point depression. Separate interpolations are made using the National Meteorological Center 2.5 deg grids and digitized versions of hand analyses made during the experiment. Extensive comparisons are made between these three data sets and the observations at three NDBC buoys. These are used to assess the accuracy of the interpolated fields and to suggest optimal ways to use them to compute surface winds, temperatures, and fluxes. The hand analyzed synoptic charts of the surface meteorology are included. The air stress and sensible heat flux are presented for the position of the Ocean Storms moorings. A data tape containing all the observations, interpolations, and fields is described. GRA

N89-26325# Wisconsin Univ., Madison. Space Science and Engineering Center.
SSM/I RAINFALL RATE ALGORITHM VALIDATION SUMMARY
15 Feb. 1989 3 p
(Contract N00014-86-K-2001)
(AD-A206933) Avail: NTIS HC A02/MF A01 CSCL 04/2

SSM/I and radar data corresponding to DMSP overpasses of the Darwin Kwajalein sites in anticipation of rain retrieval validation in the tropics are studied. Improved statistical retrieval algorithms which are based upon midlatitude validation data was used. Preliminary results are summarized and suggests that logarithmic regression formulae provide rain rate estimates more precise than linear formulae over both land and ocean surfaces when prescreening of the SSM/I data is eliminated. Model simulations were utilized to quantify the impact of the phase and spatial distribution of precipitation on observed brightness temperatures. Author

N89-26326# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
TRANSCRIPTION OF A KNOWLEDGE BASE IN METEOROLOGY FOR THE REPRESENTATION SCHEME OF THE MOTIN SYSTEM (INFERENCE MOTOR) [TRANSCRICAO DE UMA BASE DE CONHECIMENTO EM METEOROLOGIA PARA O ESQUEMA DE REPRESENTACAO DO SISTEMA MOTIN (MOTOR DE INFERENCIA)]
Helio Tinone and Pedro Paulo BalbideOliveira Sep. 1988 196 p In PORTUGUESE; ENGLISH summary
(INPE-4705-RPE/578) Avail: NTIS HC A09/MF A01

The system BOLETIM is an expert system in Meteorology that was developed at INPE by using ESE, an expert system shell developed by IBM. The rule base used in BOLETIM as transcribed into the representation scheme of MOTIN, an expert system shell developed at INPE is described. The aim of this transcription was supplying a large rule base (more than 800 rules) to MOTIN in order to test it in a more effective way. Author

N89-26327# Naval Environmental Prediction Research Facility, Monterey, CA.
ON THE CORRECTION OF SHIPBOARD MINIRADIOSONDES OF THE WESTERN MEDITERRANEAN CIRCULATION EXPERIMENT - JUNE 1986 Final Report, Sep. 1988 - Jan. 1989
Gerard N. Vogel Mar. 1989 26 p
(AD-A207208; NEPRF-TR-89-03) Avail: NTIS HC A03/MF A01 CSCL 04/2

Atmospheric soundings taken during the Western Mediterranean Circulation Experiment of June 1986 are found to contain inaccuracies due to instrument miscalibrations and ship-induced distortions. Once a criterion is established to identify those soundings in need of surface-layer modification, several corrective techniques are applied to the data. It is found that a profile correction method using surface measurements corrected for ship-induced distortions is best able to provide realistic and representative soundings within the surface layer. GRA

N89-26328*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ERBE/NOAA-9 OBSERVATIONS FOR THE FIRE/SRB WISCONSIN EXPERIMENT REGION FROM OCTOBER 14 THROUGH OCTOBER 31, 1986
Charles H. Whitlock, Lawrence H. Hoffman, and Robert F. Arduini (Planning Research Corp., Hampton, VA.) Jul. 1989 34 p
(NASA-TM-101627; NAS 1.15:101627) Avail: NTIS HC A03/MF A01 CSCL 04B

Tables are presented which show ERBE/NOAA-9 radiances, resolution size, and pixel location for the FIRE/SRB Wisconsin experiment region from October 1 through October 31, 1986. Also presented is an analysis of the ERBE point spread function used to estimate pixel resolution size for the scanner instrument. Author

N89-26329*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
AOIPS 3 USER'S GUIDE. VOLUME 1: OVERVIEW AND SOFTWARE UTILIZATION
S. S. Schotz, A. J. Negri, and W. Robinson (General Sciences Corp., Laurel, MD.) Jul. 1989 96 p
(NASA-TM-100724; Rept-89B00096; NAS 1.15:100724) Avail: NTIS HC A05/MF A01 CSCL 04B

This is Volume I of the Atmospheric and Oceanographic Information Processing System (AOIPS) User's Guide. AOIPS 3 is the version of the AOIPS software as of April 1989. The AOIPS software was developed jointly by the Goddard Space Flight Center and General Sciences Corporation. Volume 1 is intended to provide the user with an overall guide to the AOIPS system. It introduces the user to AOIPS system concepts, explains how programs are related and the necessary order of program execution, and provides brief descriptions derived from on-line help for every AOIPS program. It is intended to serve as a reference for information such as: program function, inmput/output variable descriptions, program limitations, etc. AOIPS is an interactive meteorological processing system with capabilities to ingest and analyze the many types of meteorological data. AOIPS includes several applications in areas of relevance to meteorological research. AOIPS is partitioned into four applications components: satellite data analysis, radar data analysis, aircraft data analysis, and utilities. Author

48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

N89-26330*# Johns Hopkins Univ., Baltimore, MD. Dept. of Earth and Planetary Sciences.
DYNAMIC COMPENSATION IN THE CENTRAL PACIFIC OCEAN
Juan Homero Hinojosa and Bruce D. Marsh [1988] 57 p
(Grant NAG5-32)
(NASA-CR-185458; NAS 1.26:185458) Avail: NTIS HC A04/MF A01 CSCL 08C

The intermediate-wavelength geoid (lambda similar to 2000 km) and sea-floor topography fields in the central Pacific Ocean were studied in terms of static and dynamic compensation models. Topographic features on the sea-floor with lambda less than 1000 km were found to be compensated both regionally, by the elastic strength of the lithosphere, and locally, by displacing mantle material to reach isostatic adjustment. The larger-scale sea-floor topography and the corresponding geoid anomalies with lambda similar to 2000 km cannot be explained by either local or regional compensation. The topography and the resulting geoid anomaly at this wavelength were modeled by considering the dynamic effects arising from viscous stresses in a layer of fluid with a highly temperature-dependent viscosity for the cases of: (1) surface cooling, and (2) basal heating. In this model, the mechanical properties of the elastic part of the lithosphere were taken into account by considering an activation energy of about 520 kJ/mol in the Arrhenius law for the viscosity. Numerical predictions of the topography, total geoid anomaly, and admittance were obtained, and the results show that the thermal perturbation in the layer, which accounts for the mass deficit, must be located close to the surface to compensate the gravitational effect of the surface deformation. For the case of basal heating, the temperature dependence of viscosity results in a separation of the upper, quasi-rigid lid from the lower mobile fluid, hence inhibiting the development of a compensating thermal perturbation at shallow depths. The results clearly rule out small-scale, upper-mantle convection as the source of these anomalies. Instead, the geophysical observables can be well explained by a shallow, transient thermal perturbation. Author

N89-26331# Scripps Institution of Oceanography, La Jolla, CA. Marine Physical Lab.
PROGRAM IN MARINE PHYSICS APPLIED TO NAVY UNDERSEA MISSIONS Final Report
Kenneth M. Watson Oct. 1988 16 p
(Contract N00014-87-K-0225)
(AD-A206586; MPL-U-37/88) Avail: NTIS HC A03/MF A01 CSCL 17/1

The SIO Marine Physical Lab. (MPL) Horizontal and (Vertical) Digital Acoustic Array was completed. This array can be deployed with a maximum length of 1.5 km. It operates in the 10 to 200 Hz range. The array was deployed in January 1977 from ORB. Element navigation was tested in March 1987 and an engineering deployment was made from FLIP in June 1987. This array was again deployed from FLIP in September 1987 as part of the SVLA experiment. Ambient noise and signals from acoustic sources were recorded. Data analysis from this experiment is continuing. The MPL Swallow Float Acoustic Array was deployed in September 1987 as a part of the SVLA experiment. The data from this deployment is being used to determine flow and strum contamination in the SVLA array. A high resolution Doppler velocity sensing sonar was developed. This sonar will operate in either a coherent mode (1 km range resolution 50 m range) or in an incoherent mode with 400 m range). The sonar has provided data describing small-scale velocity shears in the upper ocean. It is scheduled to be deployed in the 1989 CEAREX experiment in the Arctic Ocean. GRA

N89-26332# California Univ., Santa Barbara. Marine Science Inst.
TWO-DIMENSIONAL AND THREE-DIMENSIONAL MAGNETIC INVERSION STUDIES IN THE SOUTH ATLANTIC Final Report
Ken C. MacDonald, S. M. Carbotte, S. Welch, S. P. Miller, P. J. Fox, P. Vogt, and S. Cande 1988 83 p
(Contract N00014-87-K-0152)
(AD-A207068) Avail: NTIS HC A05/MF A01 CSCL 08/4

Our long range goals have been to achieve an understanding of crustal accretion along the Southern Mid-Atlantic Ridge. We address this problem with a combined analysis of bathymetry and sea surface magnetic data from two extensive Sea Beam surveys of the ridge between 25 deg to 28 deg S and 30 deg to 38 deg S. We are particularly interested in how crustal accretion may differ from accretion process in other areas spreading at faster and slower rates as spreading rates in the South Atlantic area fall within a transitional range in which the axial rift valley begins to disappear. The great clarity of magnetic recording in the oceanic crust of the South Atlantic has enabled us to carry out a very thorough analysis of the magnetic data which, in turn, has provided us with powerful constraints on models of volcanic and tectonic crustal generation processes at slow spreading rates. Analysis of the magnetic data has included both 2-D and 3-D inversions which remove skewness and the effects of bathymetry. From 2-D analysis we have identified isochron boundaries and constructed spreading rate history models, thus defining the evolution of the ridge-axis discontinuities in the region. We have examined transition widths for evidence of any variation in the crustal accretion process with time or location. From 3-D analysis we have created maps of crustal magnetization. GRA

N89-26333# Naval Postgraduate School, Monterey, CA.
HYDROGRAPHIC DATA FROM THE PILOT STUDY OF THE COASTAL TRANSITION ZONE (CTZ) PROGRAM, 17-26 MARCH 1987 Progress Report, Oct. 1986 - Sep. 1987
Paul F. Jessen, S. R. Ramp, and Carol A. Clark 30 Jan. 1989 218 p
(AD-A207089; NPS68-89-001) Avail: NTIS HC A10/MF A01 CSCL 08/3

Hydrographic (CTZ) data from a cruise off central California during 17 to 26 March 1987 are presented. The study area was from Pt. Reyes, CA to Pt. St. George, Oregon form the coastal 150 km offshore. A total of 96 CTZ casts to 500 m and 55 XBT drops to 750 m were made. The data are presented as individual vertical profiles, horizontal distributions, and vertical sections. The data were collected as part of the ONR Coastal Transition Zone Program, to study cold filaments, squirts, jets, and mesoscale eddies off the central California coast. GRA

51 LIFE SCIENCES (GENERAL)

N89-26334*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXOBIOLOGY AND FUTURE MARS MISSIONS
Christopher P. McKay, ed. and Wanda Davis, L., ed. Washington Mar. 1989 73 p Workshop held in Sunnyvale, CA, Mar. 1988
(NASA-CP-10027; A-89098; NAS 1.55:10027) Avail: NTIS HC A04/MF A01 CSCL 03B

Scientific questions associated with exobiology on Mars were considered and how these questions should be addressed on future Mars missions was determined. The mission that provided a focus for discussions was the Mars Rover/Sample Return Mission. For individual titles, see N89-26335 through N89-26373.

N89-26335*# California Univ., Santa Barbara. Dept. of Geological Sciences.
EARTH'S EARLY FOSSIL RECORD: WHY NOT LOOK FOR SIMILAR FOSSILS ON MARS?
Stanley M. Awramik *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 4-5 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

The oldest evidence of life on Earth is discussed with attention being given to the structure and formation of stromatolites and microfossils. Fossilization of microbes in calcium carbonate or chert media is discussed. In searching for fossil remains on Mars, some lessons learned from the study of Earth's earliest fossil record can be applied. Certain sedimentary rock types and sedimentary rock configurations should be targeted for investigation and returned by the Martian rover and ultimately by human explorers. Domical, columnar to wavy laminated stratiform sedimentary rocks that resemble stromatolites should be actively sought. Limestone, other carbonates, and chert are the favored lithology. Being macroscopic, stromatolites might be recognized by an intelligent unmanned rover. In addition, black, waxy chert with conchoidal fracture should be sought. Chert is by far the preferred lithology for the preservation of microbes and chemical fossils. Even under optimal geological conditions (little or no metamorphism or tectonic alteration, excellent outcrops, and good black chert) and using experienced field biogeologists, the chances of finding well preserved microbial remains in chert are very low. A.D.

N89-26336*# Hebrew Univ., Jerusalem (Israel). Dept. of Soil and Water Science.
VIKING BIOLOGY EXPERIMENTS AND THE MARTIAN SOIL Abstract Only **c55**
Amos Banin *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 6 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

The Viking Biology Experiments (VBE) are the most informative database on the wet chemistry and reactivity of the Martian soil available today. The simulation and chemical interpretation of the results have given valuable hints towards the characterization of the soils' mineralogy, adsorption properties, pH and redox. The characterization of Mars' soil on the basis of ten years of labelled release (LR) and other VBE simulations are reviewed. Author

N89-26337*# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia). Div. of Continental Geology.
MICROBIAL MATS IN PLAYA LAKES AND OTHER SALINE HABITATS: EARLY MARS ANALOG? Abstract Only **c55**
John Bauld *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 7-8 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

Microbial mats are cohesive benthic microbial communities which inhabit various Terra (Earth-based) environments including the marine littoral and both permanent and ephemeral (playa) saline lakes. Certain geomorphological features of Mars, such as the Margaritifer Sinus, were interpreted as ancient, dried playa lakes, presumably formed before or during the transition to the present Mars climate. Studies of modern Terran examples suggest that microbial mats on early Mars would have had the capacity to survive and propagate under environmental constraints that would have included irregularly fluctuating regimes of water activity and high ultraviolet flux. Assuming that such microbial communities did indeed inhabit early Mars, their detection during the Mars Rover Sample Return (MRSR) mission depends upon the presence of features diagnostic of the prior existence of these communities or their component microbes or, as an aid to choosing suitable landing, local exploration or sampling sites, geomorphological, sedimentological or chemical features characteristic of their playa lake habitats. Examination of modern Terran playas (e.g., the Lake Eyre basin) shows that these features span several orders of magnitude in size. While stromatolites are commonly centimeter-meter scale features, bioherms or fields of individuals may extend to larger scales. Preservation of organic matter (mats and microbes) would be favored in topographic lows such as channels or ponds of high salinity, particularly those receiving silica-rich groundwaters. These areas are likely to be located near former zones of groundwater emergence and/or where flood

channels entered the paleo-playa. Fossil playa systems which may aid in assessing the applicability of this particular Mars analog include the Cambrian Observatory Hill Beds of the Officer Basin and the Eocene Wilkins Peak Member of the Green River Formation. Author

N89-26338*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STABLE ISOTOPE LASER SPECTROSCOPY Abstract Only **c19**
J. F. Becker, Ramil Yaldaei (San Jose State Univ., CA.), and Christopher P. McKay *In its* Exobiology and Future Mars Missions Mar. 1989 p 9 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 14B

Recent advances in semiconductor laser technology have produced a reliable lightweight device ideally suited for a spacecraft high resolution molecular spectrometer. Lead-salt tunable diode lasers (TDL) emit in several spectral modes, each with a very narrow linewidth of -0.0003/cm. This spectral resolution is much narrower than typical Doppler broadened molecular linewidths in the mid-IR range. Thus it is possible to detect individual rotational lines within the vibrational band and measure their intensity, which can be used to determine gas concentration. The narrow spectral lines of any impurity gas tend to lie between the narrow lines of the gas of interest. This represents a major advantage over the accepted gas chromatograph mass spectrometer (GCMS) technique for measuring gas concentrations and isotope ratios. The careful and extensive gas purification procedures required to remove impurities for reliable GCMS measurements will not be required for an IR laser gas analysis. The infrared laser gas analysis technique is being developed to measure stable isotopic ratios of gases such as CO2, CH4, N2O, and NH3. This will eventually lead to development of instruments capable of in situ istopic measurements on planets such as Mars. The carbon (C-12, C-13) isotope ratio is indicative of the type of carbon fixation mechanisms (e.g., photosynthesis, respiration) in operation on a planet, while the nitrogen (N-14, N-15) isotope ratio can probably be used to date nitrogen-bearing Martian samples. The absorbance ratio of two adjacent lines of CO2 in the 2300/cm (4.3 micron) region of the spectrum was measured. The precision of the measurement is presently better than 1 percent and significant improvement is anticipated as rapid sweep-integration techniques and computer controlled data acquistion capabilities are incorporated. Author

N89-26339*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYTICAL ELECTRON MICROSCOPY OF BIOGENIC AND INORGANIC CARBONATES Abstract Only
David F. Blake *In its* Exobiology and Future Mars Missions Mar. 1989 p 10 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

In the terrestrial sedimentary environment, the mineralogically predominant carbonates are calcite-type minerals (rhombohedral carbonates) and aragonite-type minerals (orthorhombic carbonates). Most common minerals precipitating either inorganically or biogenically are high magnesium calcite and aragonite. High magnesium calcite (with magnesium carbonate substituting for more than 7 mole percent of the calcium carbonate) is stable only at temperatures greater than 700 C or thereabouts, and aragonite is stable only at pressures exceeding several kilobars of confining pressure. Therefore, these carbonates are expected to undergo chemical stabilization in the diagenetic environment to ultimately form stable calcite and dolomite. Because of the strong organic control of carbonate deposition in organisms during biomineralization, the microchemistry and microstructure of invertebrate skeletal material is much different than that present in inorganic carbonate cements. The style of preservation of microstructural features in skeletal material is therefore often quite distinctive when compared to that of inorganic carbonate even though wholesale recrystallization of the sediment has taken place. Microstructural and microchemical comparisons are made between high magnesium calcite echinoderm skeletal material and modern inorganic high magnesium calcite inorganic cements, using analytical electron microscopy and related techniques. Similar comparisons are made between analogous materials which have undergone stabilization in the diagenetic environment. Similar analysis schemes may prove useful in distinguishing between biogenic and inorganic carbonates in returned Martian carbonate samples. Author

N89-26340*# Geological Survey, Menlo Park, CA.
RATIONALE FOR MARS ROVER/SAMPLER RETURN MISSION Abstract Only **c91**
Michael H. Carr *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 11 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

A Mars Rover/Sample Return (MRSR) mission is currently being studied for the late 1990's. The objectives of the mission are to better understand the origin and evolution of Mars, to search for evidence of former life, and to improve the knowledge of the Martian environment in preparation for subsequent human exploration. Having formed in a different part of the Solar System from Earth, Mars will provide clues that will better enable the discrimination between conflicting theories of Solar System formations. Mars is also a natural laboratory on which a wide range of geologic and meteorological processes have operated under conditions very different from those on Earth. Samples are needed so that the full range of analytical techniques available here on Earth can be applied to the study of these issues. The rover provides the mobility needed to access different materials, and can be equipped with an analytical capability so that the planet can be sampled intelligently. The rover will also provide the means of exploring the planet on a human scale and performing a wide range of in situ measurements at different locations. Different mission scenarios are currently being studied with the goal of achieveing sample return before the end of the century. Author

N89-26341*# San Jose State Univ., CA. Dept. of Chemistry.
USE OF NEAR INFRARED CORRELATION SPECTROSCOPY FOR QUANTITATION OF SURFACE IRON, ABSORBED WATER AND STORED ELECTRONIC ENERGY IN A SUITE OF MARS SOIL ANALOG MATERIALS Abstract Only **c91**
Lelia M. Coyne, Amos Banin (Hebrew Univ., Jerusalem, Israel), Glenn Carle, James Orenberg, and Thomas Scattergood *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 12 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

A number of questions concerning the surface mineralogy and the history of water on Mars remain unresolved using the Viking analyses and Earth-based telescopic data. Identification and quantitation of iron-bearing clays on Mars would elucidate these outstanding issues. Near infrared correlation analysis, a method typically applied to qualitative and quantitative analysis of individual constituents of multicomponent mixtures, is adapted here to selection of distinctive features of a small, highly homologous series of Fe/Ca-exchanged montmorillonites and several kalinites. Independently determined measures of surface iron, relative humidity and stored electronic energy were used as constituent data for linear regression of the constituent vs. reflectance data throughout the spectral region 0.68 to 2.5 micrometers. High correlations were found in appropriate regions for all three constituents, though that with stored energy is still considered tenuous. Quantitation was improved using 1st and 2nd derivative spectra. High resolution data over a broad spectral range would be required to quantitatively identify iron-bearing clays by remotely sensed reflectance. Author

N89-26342*# California Univ., Davis. Dept. of Zoology.
LIFE WITHOUT WATER Abstract Only
Lois M. Crowe and John H. Crowe *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989

p 13-14 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Anhydrobiosis, or life without water is commonly demonstrated by a number of plants and animals. These organisms have the capacity to loose all body water, remain dry for various periods, and then be revived by rehydration. While in the anhydrobiotic state, these organisms become highly resistant to several environmental stresses such as extremely low temperatures, elevated temperatures, ionizing radiation, and high vacuum. Since water is commonly thought to be essential for life, survival of anhydrobiotic organisms with an almost total loss of water is examined. A search of literature reveal that many anhydrobiotic organisms make large quantities of trehalose or other carbohydrates. Laboratory experiments have shown that trehalose is able to stabilize and preserve microsomes of sarcoplasmic reticulum and artificial liposomes. It was demonstrated that trehalose and other disaccharides can interact directly with phosopipid headgroups and maintain membranes in their native configuration by replacing water in the headgroup region. Recent studies show that trehalose is an effective stabilizer of proteins during drying and that it does so by direct interaction with groups on the protein. If life that is able to withstand environmental extremes has ever developed on Mars, it is expected that such life would have developed some protective compounds which can stabilize macromolecular structure in the absence of water and at cold temperatures. On Earth, that role appears to be filled by carbohydrates that can stabilize both membrane and protein stuctures during freezing and drying. By analog with terrestrial systems, such life forms might develop resistance either during some reproductive stage or at any time during adult existence. If the resistant form is a developmental stage, the life cycle of the organism must be completed with a reasonable time period relative to time when environmental conditions are favorable. This would suggest that simple organisms with a short life cycle might be most successful. Author

N89-26343*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STABLE CARBON AND SULFUR ISOTOPES AS RECORDS OF THE EARLY BIOSPHERE Abstract Only
David J. DesMarais *In its* Exobiology and Future Mars Missions Mar. 1989 p 15-1 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

The abundance ratios of the stable isotopes of light elements such as carbon and sulfur can differ between various naturally-occurring chemical compounds. If coexisting compounds have achieved mutual chemical and isotopic equilibrium, then the relative isotopic composition can record the conditions at which equilibrium was last maintained. If coexisting chemical compounds indeed formed simultaneously but had not achieved mutual equilibrium, then their relative isotopic compositions often reflect the conditions and mechanisms associated with the kinetically controlled reactions responsible for their production. In the context of Mars, the stable isotopic compositions of various minerals might record not only the earlier environmental conditions of the planet, but also whether or not the chemistry of life ever occurred there. Two major geochemical reservoirs occur in Earth's crust, both for carbon and sulfur. In rocks formed in low temperature sedimentary environments, the oxidized forms of these elements tend to be enriched in the isotope having the larger mass, relative to the reduced forms. In sediments where the organics and sulfides were formed by biological processes, these isotopic contrasts were caused by the processes of biological CO2 fixation and dissimilatory sulfate reduction. Such isotopic contrasts between oxidized and reduced forms of carbon and sulfur are permitted by thermodynamics at ambient temperatures. However, nonbiological chemical reactions associated with the production of organic matter and the reduction of organics and sulfides are extremely slow at ambient temperatures. Thus the synthesis of organics and sulfides under ambient conditions illustrates life's profound role as a chemical catalyst that has altered the chemistry of Earth's crust. Because the stable isotopes of carbon and sulfur can reflect their chemistry, they are useful probes of the Martian surface. Author

N89-26344*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
METHODS AND DECISION MAKING ON A MARS ROVER FOR IDENTIFICATION OF FOSSILS Abstract Only **c14**
Susan Eberlein and Gigi Yates *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 17-18 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 14B

A system for automated fusion and interpretation of image data from multiple sensors, including multispectral data from an imaging spectrometer is being developed. Classical artificial intelligence techniques and artificial neural networks are employed to make real time decision based on current input and known scientific goals. Emphasis is placed on identifying minerals which could indicate past life activity or an environment supportive of life. Multispectral data can be used for geological analysis because different minerals have characteristic spectral reflectance in the visible and near infrared range. Classification of each spectrum into a broad class, based on overall spectral shape and locations of absorption bands is possible in real time using artificial neural networks. The goal of the system is twofold: multisensor and multispectral data must be interpreted in real time so that potentially interesting sites can be flagged and investigated in more detail while the rover is near those sites; and the sensed data must be reduced to the most compact form possible without loss of crucial information. Autonomous decision making will allow a rover to achieve maximum scientific benefit from a mission. Both a classical rule based approach and a decision neural network for making real time choices are being considered. Neural nets may work well for adaptive decision making. A neural net can be trained to work in two steps. First, the actual input state is mapped to the closest of a number of memorized states. After weighing the importance of various input parameters, the net produces an output decision based on the matched memory state. Real time, autonomous image data analysis and decision making capabilities are required for achieving maximum scientific benefit from a rover mission. The system under development will enhance the chances of identifying fossils or environments capable of supporting life on Mars Author

N89-26345*# Desert Research Inst., Reno, NV.
DISTRIBUTION OF DESERT VARNISH IN ARIZONA Abstract Only **c46**
Christopher D. Elvidge *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 19 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 08G

Desert varnish is the dark coat of clay and ferromanganese oxides developed on exposed rock surfaces in arid regions. It forms from the accretion of material from windblown dust. The distribution of desert varnish was mapped in Arizona. It was discovered that desert varnish could be mapped on a regional scale. Well developed desert varnish is common on stable rock surfaces in areas having alkaline soils and less than about 25 cm of annual precipitation. Rock surfaces in areas having more than 40 cm of annual precipitation are generally devoid of desert varnish. An experiment was conducted with varnished desert pavement stone. The stones were broken in half and half was set on a roof in central Illinois from April until October. Removed from the alkaline desert environment, it only took seven months for the varnish to develop an eroded appearance. This experiment graphically illustrates the dependency of desert varnish on alkalinity. In this context, the zones of eroded desert varnish in Arizona indicate that the area of active desert varnish formation has fluctuated, expanding in drier times and contracting/eroding in wetter times. Author

N89-26346*# Indiana Univ., Bloomington. Biogeochemical Labs.

ISOTOPE RATIO MONITORING GAS CHROMATOGRAPHY MASS SPECTROMETRY (IRM-GCMS) Abstract Only **c25**

K. H. Freeman, S. A. Ricci, A. Studley, and J. M. Hayes *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 20-21 (For primary document see N89-26334 20-51)

Avail: NTIS HC A04/MF A01 CSCL 07D

On Earth, the C-13 content of organic compounds is depleted by roughly 13 to 23 permil from atmospheric carbon dioxide. This difference is largely due to isotope effects associated with the fixation of inorganic carbon by photosynthetic organisms. If life once existed on Mars, then it is reasonable to expect to observe a similar fractionation. Although the strongly oxidizing conditions on the surface of Mars make preservation of ancient organic material unlikely, carbon-isotope evidence for the existence of life on Mars may still be preserved. Carbon depleted in C-13 could be preserved either in organic compounds within buried sediments, or in carbonate minerals produced by the oxidation of organic material. A technique is introduced for rapid and precise measurement of the C-13 contents of individual organic compounds. A gas chromatograph is coupled to an isotope-ratio mass spectrometer through a combustion interface, enabling on-line isotopic analysis of isolated compounds. The isotope ratios are determined by integration of ion currents over the course of each chromatographic peak. Software incorporates automatic peak determination, corrections for background, and deconvolution of overlapped peaks. Overall performance of the instrument was evaluated by the analysis of a mixture of high purity n-alkanes of know isotopic composition. Isotopic values measured via IRM-GCMS averaged withing 0.55 permil of their conventionally measured values. Author

N89-26347*# Florida State Univ., Tallahassee. Polar Desert Research Center and the Dept. of Biological Science.

MICROBIAL TRACE FOSSILS IN ANTARCTICA AND THE SEARCH FOR EVIDENCE OF EARLY LIFE ON MARS Abstract Only

E. Imre Friedmann and Roseli O. Friedmann (Florida Agricultural and Mechanical Univ., Tallahassee.) *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 22 (For primary document see N89-26334 20-51)

Avail: NTIS HC A04/MF A01 CSCL 06C

It is possible to hypothesize that, if microbial life evolved on early Mars, fossil remnants of these organisms may be preserved on the surface. However, the cooling and drying of Mars probably resembled a cold desert and such an environment is not suitable for the process of fossilization. The frigid Ross Desert of Antarctica is probably the closest terrestrial analog to conditions that may have prevailed on the surface of the cooling and drying Mars. In this desert, cryptoendolithic microbial communities live in the airspaces of porous rocks, the last habitable niche in a hostile outside environment. The organisms produce characteristic chemical and physical changes in the rock substrate. Environmental changes (deterioration of conditions) may result in the death of the community. Although no cellular structures are fossilized, the conspicuous changes in the rock substrate are preserved as trace fossils. Likewise, microbial trace fossils (without cellular structures) may also be preserved on Mars: Discontinuities in structure or chemistry of the rock that are independent of physical or chemical gradients may be of biological origin. Ross Desert trace fossils can be used as a model for planning search strategies and for instrument design to find evidence of past Martian life. Author

N89-26348*# Missouri Univ., Columbia.

THE SEARCH FOR AND IDENTIFICATION OF AMINO ACIDS, NUCLEOBASES AND NUCLEOSIDES IN SAMPLES RETURNED FROM MARS Abstract Only

Charles W. Gehrke, Cyril Ponnamperuma, Kenneth C. Kuo, David L. Stalling, and Robert W. Zumwalt (Cancer Research Center, Columbia, MO.) *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 23-24 Previously announced as N89-18318 (For primary document see N89-26334 20-51)

Avail: NTIS HC A04/MF A01 CSCL 06C

An investigation of the returned Mars samples for biologically important organic compounds, with emphasis on amino acid, the puring and pyrimidine bases, and nucleosides is proposed. These studies would be conducted on subsurface samples obtained by drilling past the surface oxidizing layer with emphasis on samples containing the larges quantities of organic carbon as determined by the rover gas chromatographic mass spectrometer (GCMS). Extraction of these molecules from the returned samples will be performed using the hydrothermal extraction technique described by Cheng and Ponnamperuma. More rigorous extraction methods will be developed and evaluated. For analysis of the extract for free amino acids or amino acids present in a bound or peptidic form, aliquots will be analyzed by capillary GCMS both before and after hydrolysis with 6N hydrochloric acid. Establishment of the presence of amino acids would then lead to the next logical step which would be the use of chiral stationary gas chromatography phases to determine the enatiomeic composition of the amino acids present, and thus potentially establish their biotic or abiotic origin. Confirmational analyses for amino acids would include ion-exchange and reversed-phase liquid chromatographic analysis. For analyses of the returned Mars samples for nucleobases and nucleosides, affinity and reversed-phase liquid chromatography would be utilized. This technology coupled with scanning UV detection for identification, presents a powerful tool for nucleobase and nucleoside analysis. Mass spectrometric analysis of these compounds would confirm their presence in samples returned form Mars. Author

N89-26349*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

SOIL DEVELOPMENTS IN POLAR DESERTS: IMPLICATIONS FOR EXOBIOLOGY AND FUTURE MARS MISSIONS Abstract Only

Everett K. Gibson, Jr. *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 25 (For primary document see N89-26334 20-51)

Avail: NTIS HC A04/MF A01 CSCL 06C

Chemical alterations, weathering, and diagenesis of soil profiles from the dry valleys of Antarctica were studied as analogs of regolith development for the Martian regolith. Chemical weathering processes play an important part in soil development within the dry valleys of Antarctica. A suite of core samples were studied which were taken within the valley floors in addition to samples taken in the vicinity of evaporite and brine ponds. Analysis of water soluable cations and anions from core samples were performed along with petrographic analysis of selected samples. It was shown that ionic transport processes operate primarily above the permafrost zone. Abundances of the water soluable ions reflect the nature of secondary minerals produced by evaporation and weathering. Chloride, calcium, and sodium abundances for soils from the cores within the North and South Forks of Wright Valley, reflect the secondary mineralogy of the soil columns. Calculations for Na, Ca, and Cl abundances reflect the appearance of halite and antarcticite. In areas where excess Ca is present, X-ray diffraction studies show the presence of gypsum. It is well known that the Martian surface conditions may be favorable for chemical weathering. Primary silicates would be expected to be reactive with any ground water. It seems likely that Martian subsurface water is available to assist in the weathering of the primary minerals. Such weathering could result in the formation of clays, sulfates, carbonates, hydrates, halides, and zeolites. The dry valley cores have shown that they maybe excellent analogs to weathering processes on the near-surface of Mars. Since movement of water within the near-surface region clearly results in chemical weathering, leaching, and salt formation in the dry valleys, similar processes are probably operating within the Martian regolith.

Author

N89-26350*# Cornell Univ., Ithaca, NY.

ANCIENT LAKES ON MARS? Abstract Only **c91**

J. M. Goldspiel and S. W. Squyres *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 26 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

The valley systems in Mars' ancient cratered terrain provide strong evidence for a warmer and wetter climate very early in planetary history. The valley systems in some instances debouch into closed depressions that could have acted as local ponding basins for the flow. A survey of the Martian equatorial region shows that numerous local depressions at the confluence of valley systems exist. These depressions (approximately 100 km) typically are characterized by many valleys flowing into them and few or none flowing out. If ponding did take place, these basin would have contained lakes for some period during Mars' early warmer epoch. Although the collection basins are numerous, location of ones that have not suffered significant subsequent geologic modification is difficult. Some morphologic features suggest that volcanic lavas may have filled them subsequent to any early fluvial activity. Two detailed maps of valley systems and local ponding basins in USGC 1:2,000,000 subquadrangles were completed and a third is in progress. The completed regions are in Mare Tyrrhenum (MC-22 SW) and Margarifter Sinus (MC-19 SE), and the region in progress is in lapygia (MC-21 NW). On the maps, the valley systems and interpreted margins of ponding basins are indicated. The depressions are of interest for two reasons. First, the depressions were surely the sites in which the materials eroded from the valleys were deposited. Such sediments could preserve important information about the physical conditions at the time of deposition. Second, the sediments could preserve evidence of water-atmosphere interactions during the early period of the Martian climate. Atmospheric carbon dioxide would dissolve in water, and solid carbonate minerals would tend to precipitate out to form carbonate sedimentary deposits. Formation of carbonates in this manner might account for some of the CO2 lost from the early more dense atmosphere. Author

N89-26351*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MINERALOGICAL SINKS FOR BIOGENIC ELEMENTS ON MARS Abstract Only
J. L. Gooding *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 27-28 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

The efficacy of biochemical reactions on Mars should depend not only on concentrations of the biogenic elements H, C, N, O, and S but also on the forms (compounds and water-souble ions) that are available to those elements. It is possible that mineralogical reactions could act to lock biogenic elements into relatively inaccessible inorganic forms or, alternatively, to shelter sensitive organic compounds from chemically hostile environments. Recognition of these competing pathways is essential in planning sampling mission and in situ experiments directed toward assessing the biological potential of Mars. Author

N89-26352*# Wisconsin Univ., Madison.
A CORE HANDLING DEVICE FOR THE MARS SAMPLE RETURN MISSION Abstract Only **c91**
Owen Gwynne *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 29 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

A core handling device for use on Mars is being designed. To provide a context for the design study, it was assumed that a Mars Rover/Sample Return (MRSR) Mission would have the following characteristics: a year or more in length; visits by the rover to 50 or more sites; 100 or more meter-long cores being drilled by the rover; and the capability of returning about 5 kg of Mars regolith to Earth. These characteristics lead to the belief that in order to bring back a variegated set of samples that can address the range of scientific objetives for a MRSR mission to Mars there needs to be considerable analysis done on board the rover. Furthermore, the discrepancy between the amount of sample gathered and the amount to be returned suggests that there needs to be some method of choosing the optimal set of samples. This type of analysis will require pristine material-unaltered by the drilling process. Since the core drill thermally and mechanically alters the outer diameter (about 10 pct) of the core sample, this outer area cannot be used. The primary function of the core handling device is to extract subsamples from the core and to position these subsamples, and the core itself if needed, with respect to the various analytical instruments that can be used to perform these analyses. Author

N89-26353*# California Univ., Berkeley.
MARS, CLAYS AND THE ORIGINS OF LIFE Abstract Only
Hyman Hartman *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 30-31 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

To detect life in the Martian soil, tests were designed to look for respiration and photosynthesis. Both tests (labeled release, LR, and pyrolytic release, PR) for life in the Martian soils were positive. However, when the measurement for organic molecules in the soil of Mars was made, none were found. The interpretation given is that the inorganic constituents of the soil of Mars were responsible for these observations. The inorganic analysis of the soil was best fitted by a mixture of minerals: 60 to 80 percent clay, iron oxide, quartz, and soluble salts such as halite (NaCl). The minerals most successful in simulating the PR and LR experiments are iron-rich clays. There is a theory that considers clays as the first organisms capable of replication, mutation, and catalysis, and hence of evolving. Clays are formed when liquid water causes the weathering of rocks. The distribution of ions such as aluminum, magnesium, and iron play the role of bases in the DNA. The information was stored in the distribution of ions in the octahedral and tetrahedral molecules, but that they could, like RNA and DNA, replicate. When the clays replicated, each sheet of clay would be a template for a new sheet. The ion substitutions in one clay sheet would give rise to a complementary or similar pattern on the clay synthesized on its surface. It was theorized that it was on the surface of replicating iron-rich clays that carbon dioxide would be fixed in the light into organic acids such as formic or oxalic acid. If Mars had liquid water during a warm period in its past, clay formation would have been abundant. These clays would have replicated and evolved until the liquid water was removed due to cooling of Mars. It is entirely possible that the Viking mission detected life on Mars, but it was clay life that awaits the return of water to continue its evolution into life based on organic molecules. Author

N89-26354*# Colgate Univ., Hamilton, NY. Dept. of Biology.
SNOW AS A HABITAT FOR MICROORGANISMS Abstract Only
Ronald W. Hoham *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 32-33 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

There are three major habitats involving ice and snow, and the microorganisms studied from these habitats are most eukaryotic. Sea ice is inhabited by algae called diatoms, glacial ice has sparse populations of green algai cal desmids, and the temporary and permanent snows in mountainous regions and high latitudes are inhabited mostly by green algal flagellates. The life cycle of green algal flagellates is summarized by discussing the effects of light, temperature, nutrients, and snow melts. Specific examples of optimal conditions and environmental effects for various snow algae are given. It is not likely that the eukaryotic snow algae presented are candidated for life on the planet Mars. Evolutionally, eukaryotic cells as know on Earth may not have had the opportunity to develop on Mars (if life evolved at all on Mars) since eukaryotes did not appear on Earth until almost two billion years after the first prokaryotic organisms. However, the snow/ice ecosystems on Earth present themselves as extreme habitats were there is evidence of prokaryotic life (eubacteria and cyanbacteria) of which literally nothing is known. Any future surveillances of extant and/or extinct life on Mars should include

probes (if not landing sites) to investigate sites of concentrations of ice water. The possibility of signs of life in Martian polar regions should not be overlooked. B.G.

N89-26355*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CHEMICAL EVOLUTION AND THE PRESERVATION OF ORGANIC COMPOUNDS ON MARS Abstract Only
Anastassia Kanavarioti (California Univ., Santa Cruz.) and Rocco L. Mancinelli *In its* Exobiology and Future Mars Missions Mar. 1989 p 34-3 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Several lines of evidence suggest that the environment on early Mars and early Earth were very similar. Since life is abundant on Earth, it seems likely that conditions on early Earth were conducive to chemical evolution and the origin of life. The similarity between early Mars and early Earth encourages the hypothesis that chemical evolution might have also occurred on Mars, but that decreasing temperatures and the loss of its atmosphere brought the evolution to a halt. The possibility of finding on Mars remnants of organic material dating back to this early clement period is addressed. Author

N89-26356*# Santa Clara Univ., CA. Dept. of Biology.
THE VIKING BIOLOGY RESULTS Abstract Only
Harold P. Klein *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 36-37 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

A brief review of the purposes and the results from the Viking Biology experiments is presented, in the expectation that the lessons learned from this mission will be useful in planning future approaches to the biological exploration of Mars. Since so little was then known about potential micro-environments on Mars, three different experiments were included in the Viking mission, each one based on different assumptions about what Martian organisms might be like. In addition to the Viking Biology Instrument (VBI), important corollary information was obtained from the Viking lander imaging system and from the molecular analysis experiments that were conducted using the gas chromatograph-mass spectrometer (GCMS) instrument. No biological objects were noted by the lander imaging instrument. The GCMS did not detect any organic compounds. A description of the tests conducted by the Gas Exchange Experiment, the Labeled Release experiment, and the Pyrolytic Release experiment is given. Results are discussed. Taken as a whole, the Viking data yielded no unequivocal evidence for a Martian biota at either landing site. The results also revealed the presence of one or more reactive oxidants in the surface material and these need to be further characterized, as does the range of micro-environments, before embarking upon future searches for extant life on Mars. A.D.

N89-26357*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ECOLOGICAL CONSIDERATIONS FOR POSSIBLE MARTIAN BIOTA Abstract Only
June M. Klingler, Rocco L. Mancinelli, and Melisa R. White *In its* Exobiology and Future Mars Missions Mar. 1989 p 38 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Current climatic and geological evidence suggests that, like early Earth, conditions on ancient Mars may also have been favorable for the origin and evolution of life. The primordial atmospheres of the two planets were quite similar, composed primarily of CO2, N2, and water vapor at a total atmospheric pressure of approximately 1 bar. Each of these gases are important for the evolution of biological systems. With the exception of nitrogen, there seems to have been a sufficient supply of the biogenic elements C, H, O, P, and S (CHOPS) on early Mars for life to have evolved. It was postulated that primordial Mars contained only 18 mb of nitrogen in the form of N2 given that only fixed nitrogen is utilized by living systems. Laboratory tests performed at a total pressure of 1 bar and various partial pressures of dinitrogen (pN2 1-780 mb) show that nitrogen fixing organisms grow at pN2's of 18 mb or less, although the biomass and growth rates are decreased. The calcualted in vivo Km's ranged from 46 mb to 130 mb. If organisms adapted on Earth to a pH2 of 780 mb are capable of growing at these low partial pressures, it is conceivable that nitrogen was not the limiting factor in the evolution of life on early Mars. A.D.

N89-26358*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SEARCH FOR BIOGENIC TRACE GASES IN THE ATMOSPHERE OF MARS Abstract Only
Joel S. Levine and Christopher P. McKay (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 39 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

The detection of certain trace gases in the atmosphere of Mars may serve as a possible indicator of microbial life on the surface of Mars. Candidate biogenic gases include methane CH4, ammonia NH3, nitrous oxide N2O, and several reduced sulfur species. Chemical thermodynamic equilibrium and photochemical calculations preclude the presence of these gases in any measurable concentrations in the atmosphere of Mars in the absence of biogenic production. A search for these gases utilizing either high resolution (spectral and spatial) spectroscopy from a Mars orbiter, such as the Observer, and or in situ measurements from a Mars lander or rover, is proposed. Author

N89-26359*# Louisiana State Univ., Baton Rouge. Dept. of Geology.
THE GEOLOGICAL RECORD OF LIFE 3500 Ma AGO: COPING WITH THE RIGORS OF A YOUNG EARTH DURING LATE ACCRETION Abstract Only **c91**
Donald R. Lowe *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 40-41 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

Thin cherty sedimentary layers within the volcanic portions of the 3,500 to 3,300 Ma-old Onverwacht and Fig Tree Groups, Barberton Greenstone belt, South Africa, and Warrawoona Group, eastern Pilbara Block, Western Australia, contain an abundant record of early Archean life. Five principal types of organic and probably biogenic remains and or structures can be identifed: stromatolites, stromatolite detritus, carbonaceous laminite or flat stromalite, carbonaceous detrital particles, and microfossils. Early Archean stromatolites were reported from both the Barberton and eastern Pilbara greenstone belts. Systematic studies are lacking, but two main morphological types of stromatolites appear to be represented by these occurrences. Morphology of the stromalites is described. Preserved early Archean stromatolites and carbonaceous matter appear to reflect communities of photosynthetic cyanobacteria inhabiting shallow, probably marine environments developed over the surfaces of low-relief, rapidly subsiding, simatic volcanic platforms. The overall environmental and tectonic conditions were those that probably prevailed at Earth's surface since the simatic crust and oceans formed sometime before 3,800 Ma. Recent studies also suggest that these early Archean sequences contain layers of debris formed by large-body impacts on early Earth. If so, then these early bacterial communities had developed strategies for coping with the disruptive effects of possibly globe-encircling high-temperature impact vapor clouds, dust blankets, and impact-generated tsunamis. It is probable that these early Archean biogenic materials represent organic communities that evolved long before the beginning of the preserved geological record and were well adapted to the rigors of life on a young, volcanically active Earth during late bombardment. These conditions may have had parallels on Mars during its early evolution. A.D.

N89-26360*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE NITROGEN CYCLE ON MARS Abstract Only
Rocco L. Mancinelli *In its* Exobiology and Future Mars Missions Mar. 1989 p 42 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Nirtogen is an essential element for the evolution of life, because it is found in a variety of biologically important molecules. Therefore, N is an important element to study from a exobiological perspective. In particular, fixed nitrogen is the biologically useful form of nitrogen. Fixed nitrogen is generally defines as NH3, NH4(+), NO(x), or N that is chemically bound to either inorganic or organic molecules, and releasable by hydrolysis to NH3 or NH4(+). On Earth, the vast majority of nitrogen exists as N2 in the atmosphere, and not in the fixes form. On early Mars the same situations probably existed. The partial pressure of N2 on early Mars was thought to be 18 mb, significantly less than that of Earth. Dinitrogen can be fixed abiotically by several mechanisms. These mechanisms include thernal shock from meteoritic infall and lightning, as well as the interaction of light and sand containing TiO2 which produces NH3 that would be rapidly destroyed by photolysis and reaction with OH radicals. These mechanisms could have been operative on primitive Mars.The chemical processes effecting these compounds and possible ways of fixing or burying N in the Martian environment are described. Data gathered in this laboratory suggest that the low abundance of nitrogen along (compared to primitive Earth) may not significantly deter the origin and early evolution of a nitrogen utilizing organisms. However, the conditions on current Mars with respect to nitrogen are quite different, and organisms may not be able to utilize all of the available nitrogen. Author

N89-26361*# Academy of Sciences (USSR), Moscow. Space Research Inst.
MARS 94 MISSION: CURRENT PLANS AND SCIENCE Abstract Only c91
Lev Mukhin and Mikhail Ya. Marov *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 43 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

The Soviet Space Program proposes large-scale investigations of Mars as one of the most important trends for the next 10 to 15 years. The objectives include global studies of the surface of Mars, its atmosphere, and the return of soil samples to Earth. The first stage of the program is to be implemented in the mid-90s. It includes measurements from an orbiter and a balloon in the atmosphere and on the surface from a rover as well. This can be done using the high energy upper stage of the launch vehicle. The payload mass could amount to about 1500 to 1700 kg. The capabilities of the Mars Mission in 1994 are discussed. As presently planned, Mars will be studied concurrently with the following facilities: an orbiter with instruments for remote sensing from a polar orbit; a balloon deployed in the Martian atmosphere; a rover on the surface; a network of smaller stations on the surface; a subsatellite; and a device to return a container with photo films of the Martian surface taken with a super high resolution. If the exploration of Mars with the MARS-94 spacecraft begins late in 1994 the American Mars-Observer will still be functioning in the near-Mars orbit. Thus, joint operation of the two satellites becomes possible providing coordinated exploration, the creation of joint data banks, joint data interpretation, and the development of a joint engineering model of Mars for its further exploration. There is an opportunity for experiments and instrumentation on the Soviet missions that address questions of interest to exobiology. American scientists are invited to participate in the upcoming Soviet missions, and lend expertise to further understanding of the relationship between the physical and chemical evolution of the solar system and the appearance of life. Author

N89-26362*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ARE THERE CARBONATE DEPOSITS IN THE VALLES MARINERIS, MARS? Abstract Only c91
Susan S. Nedell and Christopher P. McKay *In its* Exobiology and Future Mars Missions Mar. 1989 p 44-4 Previously announced in IAA as A88-24972 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

The precipitation of 30 mbar of Martian atmosphere CO2 as carbonates in lakes is suggested to be the source of thick sequences of layered deposits found in the Valles Marineris. Support is adduced for this scenario from processes occurring in the perennially frozen dry valley lakes of Antarctica, where the lake water is supersaturated with atmospheric gases. Atmospheric CO2 would have accumulated in such Martian lakes as temperature fell, and the presence of an insulating ice cover would have allowed liquid water to exist. Author

N89-26363*# Houston Univ., TX. Dept. of Biochemical and Biophysical Sciences.
CHEMICAL EVOLUTION: A SOLAR SYSTEM PERSPECTIVE c90
J. Oro *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 46-49 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

During the last three decades major advances were made in the understanding of the formation of carbon compounds in the universe and of the occurrence of processes of chemical evolution in the solar system and beyond. This was made possible by the development of new astronomical techniques and by the exploration of the solar system by means of properly instrumented spacecraft. Some of the major findings made as a result of these observations are summarized. Author

N89-26364*# Indiana Univ., Bloomington. Inst. for Molecular and Cellular Biology.
PHYLOGENETIC PERSPECTIVE AND THE SEARCH FOR LIFE ON EARTH AND ELSEWHERE Abstract Only
Norman R. Pace *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 50-51 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Any search for microbial life on Mars cannot rely upon cultivation of indigenous organisms. Only a minority of even terrestrial organisms that are observed in mixed, naturally-occurring microbial populations can be cultivated in the laboratory. Consequently, methods are being developed for analyzing the phylogenetic affiliations of the constituents of natural microbial populations without the need for their cultivation. This is more than an exercise in taxonomy, for the extent of phylogenetic relatedness between unknown and known organisms is some measure of the extent of their biochemical commonalities. In one approach, total DNA is isolated from natural microbial populations and 16S rRNA genes are shotgun cloned for rapid sequence determinations and phylogenetic analyses. A second approach employs oligodeoxynucleotide hybridization probes that bind to phylogenetic group-specific sequences in 16S rRNA. Since each actively growing cell contains about 104 ribosomes, the binding of the diagnostic probes to single cells can be visualized by radioactivity or fluorescence. The application of these methods and the use of in situ cultivation techniques is illustrated using submarine hydrothermal vent communities. Recommendations are made regarding planning toward future Mars missions. Author

N89-26365*# Puget Sound Univ., Tacoma, WA. Dept. of Biology.
GROWTH OF A MAT-FORMING PHOTOGRAPH IN THE PRESENCE OF UV RADIATION Abstract Only
Beverly K. Pierson and A. L. Ruff *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989

p 52-53 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Knowledge of the survival and growth of microorganisms in the presence of ultraviolet radiation is important for understanding the potential for life to exist in environments exposed to high fluxes of UV radiation. The growth of a mat-forming phototrophic prokaryote, Chloroflexus aurantiacus, was examined in the presence of continuous high UV irradiation under otherwise optimal growth conditions. Evidence was sought for an intrinsic ability to grow in the presence of UV radiation in a carefully chosen organism known to be unusually resistant to UV radiation, of ancient lineage among the phototrophs, to resemble ancient microfossils from the Precambrian, and to be a mat-former. It was assumed that even a high intrinsic UV resistance would be inadequate for survival and growth in the presence of very high UV fluxes, and iron (Fe3+) was selected as a common, abundant UV-absorbing substance that might protest microorganisms growing in or under iron-bearing sediments. The effectiveness of Fe(3+) was tested as a UV protective agent at low concentrations in thin layers. It was concluded that intrinsic UV resistance in some organisms may account for growth, not just survival, of these organisms when exposed to high UV fluxes under otherwise optimal growth conditions in an anoxic environment. It was also concluded that Fe(3+) bearing sediments of 1 mm or less in thickness may provide an adequate shield against high UV fluxes permitting the growth of microorganisms just below their surface. As long as growth conditions were met, then the evolution and development of microorganisms would not be hampered by high UV fluxes impinging upon the surface of iron-bearing sediments. A.D.

N89-26366*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VIKING AND MARS ROVER EXOBIOLOGY Abstract Only c55
D. E. Schwartz, Rocco L. Mancinelli, and B. J. OHara *In its* Exobiology and Future Mars Missions Mar. 1989 p 54 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Other than Earth, Mars is the planet generating the greatest interest among those researching and contemplating the origin and distribution of life throughout the universe. The similarity of the early environments of Earth and Mars, and the biological evolution on early Earth provides the motivation to seriously consider the possibility of a primordial Martian biosphere. In 1975 the Viking project launched two unmanned spacecraft to Mars with the intent of finding evidence of the existence of present or past life on this planet. Three Viking Biology experiments were employed: the Labeled Release experiment, the Gas Exchange Experiment, and the Pyrolytic Release experiment. Each of these three experiments tested for microbial existence and utilization of a substrate by examining the gases evolved from specific chemical reactions. Although the results of these experiments were inconclusive, they inferred that there are no traces of extant life on Mars. However, the experiments did not specifically look for indication of extinct life. Therefore, most of the exobiologic strategies and experiments suggested for the Mars Rover Sample Return Mission involve searching for signature of extinct life. The most significant biological signatures and chemical traces to detect include: isotopic and chemical signatures of metabolic activity, anomalous concentrations of certain metals, trace and microfossils, organically preserved materials, carbonates, nitrates, and evaporites. Author

N89-26367*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MARS ROVER SAMPLE RETURN: A SAMPLE COLLECTION AND ANALYSIS STRATEGY FOR EXOBIOLOGY Abstract Only c55
M. H. Sims, M. Fischler, D. E. Schwartz, Donald A. Rosenthal, Rocco L. Mancinelli, Susan S. Nedell, E. Gamble, and Christopher P. McKay *In its* Exobiology and Future Mars Missions Mar. 1989 p 55 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

For reasons defined elsewhere it is reasonable to search for biological signatures, both chemical and morphological, of extinct life on Mars. Life on Earth requries the presence of liquid water, therefore, it is important to explore sites on Mars where standing bodies of water may have once existed. Outcrops of layered deposits within the Valles Marineris appear to be ancient lake beds. Because the outcrops are well exposed, relatively shallow core samples would be very informative. The most important biological signature to detect would be organics, microfossils, or larger stromato-like structures, although the presence of cherts, carbonates, clays, and shales would be significant. In spite of the limitations of current robotics and pattern recognition, and the limitations of rover power, computation, Earth communication bandwidth, and time delays, a partial scenario was developed to implement such a scientific investigation. The rover instrumentation and the procedures and decisions and IR spectrometer are described in detail. Preliminary results from a collaborative effort are described, which indicate the rover will be able to autonomously detect stratification, and hence will ease the interpretation burden and lead to greater scientific productivity during the rover's lifetime. A.D.

N89-26368*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ELECTRON SPIN RESONANCE (ESR) DETECTION OF ACTIVE OXYGEN SPECIES AND ORGANIC PHASES IN MARTIAN SOILS c55
Fun-Dow Tsay, Soon Sam Kim, and Ranty H. Liang *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 56-58 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

The presence of active oxygen species (O(-), O2(-), O3(-)) and other strong oxidants (Fe2O3 and Fe3O4) was invoked in interpretations of the Viking biological experiments and a model was also suggested for Martian surface chemistry. The non-biological interpretations of the biological results gain futher support as no organic compounds were detected in the Viking pyrolysis-gas chromatography mass spectrometer (GCSM) experiments at concentrations as low as 10 ppb. Electron spin resonance (ESR) measures the absorption of microwaves by a paramagnetic and/or ferromagnetic center in the presence of an external field. In many instances, ESR has the advantage of detailed submicroscopic identification of the transient species and/or unstable reaction intermediates in their environments. Since the higly active oxygen species (O(-), O2(-), O3(-), and R-O-O(-)) are all paramagnetic in nature, they can be readily detected in native form by the ESR method. Active oxygen species likely to occur in the Martian surface samples were detected by ESR in UV-irradiated samples containing MgO. A miniaturized ESR spectrometer system can be developed for the Mars Rover Sample Return Mission. The instrument can perform the following in situ Martian samples analyses: detection of active oxygen species; characterization of Martian surface chemistry and photooxidation processes; and searching for organic compounds in the form of free radicals preserved in subsoils, and detection of microfossils with Martian carbonate sediments. Author

N89-26369*# Cincinnati Univ., OH. Dept. of Biological Sciences.
THE METABOLISM OF THE ANTARTIC CRYTOENDOLITHIC MICROBIOTA Abstract Only
J. Robie Vestal *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 59 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

The carbon metabolism of the cryptoendolithic microbiota in sandstones from the Ross Desert region of Antarctica was studied in situ and in vitro. Organic and inorganic compounds were metabolized by the microbiota, with bicarbonate being metabolized maximally in the light. There was a linear response of photosynthesis to light up to 200 to 300 micromole photons/sq m/s. The community photosynthetic response to temperature was a minimum at -5 C, two optima at +5 and +15 C and a maximum

at +35 C. Photosynthetic metabolism occurred maximally in the presence of liquid water, but could occur in an environment of water vapor. Biomass of the cryptoendolithic microbiota was measured as the amount of lipid phosphate present. The in situ biomass ranged from 1.92 to 3.26 g carbon/sq m of rock and 2 orders of magnitude less than epilithic lichen microbiota from Antarctica in a location 7 degrees more north in latitude. With these data, it was possible to calculate primary production and carbon turnover in this simple microbiota. Production values ranged from 0.108 to 4.41 mg carbon/sq m/yr, while carbon turnover values ranged from 576 to 23,520 years. These values are the lowest and longest yet recorded for any ecosystem on Earth. If life did evolve on Mars to the level of prokaryotes or primitive eukaryotes, the possibility that the organisms retreated, to the protection of the inside of the rock so that metabolism could continue during planetary cooling, cannot be overlooked. Author

N89-26370*# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
FOSSIL LIFE ON MARS **c55**
M. R. Walter *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 60-61 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

Three major problems beset paleontologists searching for morphological evidence of life on early Earth: selecting a prospective site; finding biogenic structures; and distinguishing biogenic from abiogenic structures. The same problems arise on Mars. Terrestrial experience suggests that, with the techniques that can be employed remotely, ancient springs, including hot springs, are more prospective than lake deposits. If, on the other hand, the search is for chemical evidence, the strategy can be very different, and lake deposits are attractive targets. Lakes and springs frequenly occur in close proximity, and therefore a strategy that combines the two would seem to maximize the chance of success. The strategy for a search for stromatolite on Mars is discussed. Author

N89-26371*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE ANTARCTIC DRY VALLEY LAKES: RELEVANCE TO MARS Abstract Only **c46**
R. A. Wharton, Jr., Christopher P. McKay, Rocco L. Mancinelli, G. D. Clow, and G. M. Simmons, Jr. (Virginia Polytechnic Inst., Blacksburg.) *In its* Exobiology and Future Mars Missions Mar. 1989 p 62 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 08G

The similarity of the early environments of Mars and Earth, and the biological evolution which occurred on early Earth, motivates exobiologists to seriously consider the possiblity of an early Martian biota. Environments are being identified which could contain Martian life and areas which may presently contain evidence of this former life. Sediments which were thought to be deposited in large ice-covered lakes are present on Mars. Such localities were identified within some of the canyons of the Valles Marineris and more recently in the ancient terrain in the Southern Hemisphere. Perennially ice-covered Antarctic lakes are being studied in order to develop quantitative models that relate environmental factors to the nature of the biological community and sediment forming processes. These models will be applied to the Martian paleolakes to establish the scientific rationale for the exobiological study of ancient Martian sediments. Author

N89-26372*# Tennessee Univ., Knoxville. Inst. for Applied Microbiology.
DETECTION OF MICROBES IN THE SUBSURFACE Abstract Only
David C. White and Anders Tunlid *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 63-64 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

The search for evidence of microbial life in the deep subsurface of Earth has implications for the Mars Rover Sampling Return Missions program. If suitably protected environments can be found on Mars then the instrumentation to detect biomarkers could be used to examine the molecular details. Finding a lipid in Martian soil would represent possibly the simplest test for extant or extinct life. A device that could do a rapid extraction possibly using the supercritical fluid technology under development now with a detection of the carbon content would clearly indicate a sample to be returned. Author

N89-26373*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
AUTONOMOUS EXPLORATION SYSTEM: TECHNIQUES FOR INTERPRETATION OF MULTISPECTRAL DATA Abstract Only
Gigi Yates and Susan Eberlein *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 65-66 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

An on-board autonomous exploration system that fuses data from multiple sensors, and makes decisions based on scientific goals is being developed using a series of artificial neural networks. Emphasis is placed on classifying minerals into broad geological categories by analyzing multispectral data from an imaging spectrometer. Artificial neural network architectures are being investigated for pattern matching and feature detection, information extraction, and decision making. As a first step, a stereogrammetry net extracts distance data from two gray scale stereo images. For each distance plane, the output is the probable mineral composition of the region, and a list of spectral features such as peaks, valleys, or plateaus, showing the characteristics of energy absorption and reflection. The classifier net is constructed using a grandmother cell architecture: an input layer of spectral data, an intermediate processor, and an output value. The feature detector is a three-layer feed-forward network that was developed to map input spectra to four geological classes, and will later be expanded to encompass more classes. Results from the classifier and feature detector nets will help to determine the relative importance of the region being examined with regard to current scientific goals of the system. This information is fed into a decision making neural net along with data from other sensors to decide on a plan of activity. A plan may be to examine the region at higher resolution, move closer, employ other sensors, or record an image and transmit it back to Earth. Author

N89-26374# Washington Univ., Seattle. Dept. of Medicine.
INFLUENCE OF STRESS-INDUCED CATECHOLAMINES ON MACROPHAGE PHAGOCYTOSIS Annual Report, 1 Jan. - 31 Dec. 1988
Itamar B. Abrass and Christine K. Abrass 1 Apr. 1989 25 p (Contract N00014-87-K-0369; NADC Proj. RR-0-4-108)
(AD-A206608) Avail: NTIS HC A02/MF A01 CSCL 06/1

Beta-adrenergic receptor concentration and adenylate cyclase activity change with macrophage activation. Resident (R) and thioglycollate (TG)-stimulated macrophages (MO) have comparable concentrations of beta-adrenergic receptors (2136 +/-143 and 2110 +/-327 sites/cell respectively), while Bacillus Calmette Guerin (BCG)-activated macrophages have 62% fewer beta-adrenergic receptors (808 +/-190 sites/cell). The increase resident-macrophages results in increased sensitivity to catecholamines. FcR-mediated phagocytosis is dependent on FcR concentration, internalization and intra-cellular digestion of receptor-bound material. Catecholamines increase the receptor-bound material. Catecholamines increase the concentration of FcR which in turn increases the availability of immune complexes for phagocytosis by the cell. Catecholamines also decrease internalization and/or digestion of FcR-bound immune complexes. Thus, the net effect of catecholamines on total phagocytosis is the consequence of the balance of independent effects of catecholamines on FcR concentration and the efficiency of internalization and degradation of bound material. GRA

N89-26375# Massachusetts Inst. of Tech., Cambridge. Lab. for Electromagnetic and Electronic Systems.
THEORETICAL MODELS FOR INTERACTION OF ELECTROMAGNETIC FIELDS WITH BIOLOGICAL TISSUES Final Report, 1 Jul. 1986 - 1 Jul. 1988
Jeremy H. Nussbaum and Alan J. Grodzinsky Jan. 1989 28 p
(Contract F33615-83-D-0601)
(AD-A206923; USAFSAM-TR-88-18) Avail: NTIS HC A03/MF A01 CSCL 06/7

This work demonstrates that electric fields can modulate intra-membrane ionic concentrations, transmembrane ionic fluxes, mechanical conformation of membranes, and transmembrane potential. Even symmetrically applied fields of opposite polarities can result in asymmetric mechanical, concentration and flux responses, hence rectification of electrochemical and electrochemical phenomena can produce long-term effects even though the induced change is small. The general electro-mechano-chemical model presented predicts rectification phenomena and includes mechanical and electromechanical conformational change dynamics. GRA

52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

N89-26376# Northrop Services, Inc., Dayton, OH. Environmental Sciences.
THE 1987 TOXIC HAZARDS RESEARCH UNIT Annual Report, Oct. 1986 - Oct. 1987
William E. Houston and Raymond S. Kutzman Mar. 1988 208 p
(Contract F33615-85-C-0532; AF Proj. 6302)
(AD-A198097; NMRI-88-11; AAMRL-TR-88-008) Avail: NTIS HC A10/MF A01 CSCL 06/19

A review is presented of the activities of the Toxic Hazards Research Unit. Research focused on toxicity evaluations of aerospace and naval chemicals and materials to include hydraulic fluids, lubricating oils, groundwater contaminants, chemical defense simulants and binary agent components. Physiologically based pharmacokinetic/pharmacodynamic modeling was developed and provides methods for simulating the toxicolgical effects of selected chemicals, including models for chemical carcinogenesis. The completion and utilization of the General Toxicology Laboratory within the THRU has resulted in the completion of an increased number of acute and repeated treatment studies, and additional subchronic studies are planned. Author

N89-26377# Stanford Univ., CA. Dept. of Dermatology.
GAMMA INTERFERON REDUCES THE SYNTHESIS OF FIBRONECTIN BY HUMAN KERATINOCYTES
Vera B. Morhenn, Shelia T. Huang, and Jonathan N. Mansbridge (Psoriasis Research Inst., Stanford, CA.) 6 Oct. 1988 21 p
(Contract N00014-87-K-0216)
(AD-A206645) Avail: NTIS HC A02/MF A01 CSCL 06/1

Recombinant gamma interferon (rIFN-y) has a variety of effects on human keratinocytes including the induction of synthesis and expression of HLA-DR antigen as well as growth inhibition. In order to ascertain whether rIFN-y affects the keratinocytes capacity to interact with other skin cells and potentially alter the composition of skin proteins, we tested the effect of rIFN-y on the secretion of proteins by keratinocytes in vitro. Keratinocytes grown in serum free medium were treated with increasing concentrations of rIFN-y(3 U/ml-1000 U/Ml). The cells were radiolabeled with 35-S-methionine and the supernatants were harvested, excess 35-S-methionine removed, and the proteins analyzed by polyacrylamide gel electrophoresis. The relative synthesis of several proteins was altered by rIFN-y treatment. In particular rIFN-y decreased the synthesis of two proteins, one with a molecular weight of approximately 250 kD and the other 180 kD, and increased the synthesis of an approximately 100 kD protein in a dose dependent manner. Immunoprecipitation with polyclonal anti-fibronectin antibody showed that the 250 kD protein is the fibronectin monomer. No smaller fragments of fibronectin were immunoprecipitated, suggesting that the reduction in extracellular fibronectin following treatment by rIFN-y was not a direct result of proteolytic enzyme digestion. GRA

N89-26378# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
PREVALENCE OF DISEASE AMONG ACTIVE CIVIL AIRMEN Final Report
Charles F. Booze, Jr. Oct. 1988 13 p
(AD-A206707; DOT/FAA/AM-89/2) Avail: NTIS HC A03/MF A01 CSCL 06/5

It has been the policy of the Federal Aviation Administration to medically certify, for a variety of flying privileges, individuals who have a medical deficiency or disease, provided it can be determined that such action does not compromise air safety. This descriptive epidemiologic study presents the point prevalence of pathology among 685,552 active airmen as of January 1, 1988, by major body system. The study also presents other selected pathologies of interest within the major body system. Cardiovascular, eye, and abdominal pathologies represent the most prevalent medical conditions among active airmen (7.5 percent, 6.4 percent and 6.3 percent respectively). Hypertension is the most frequently occurring cardiovascular condition. Prevalence of pathology among active civil airmen, while still considerably less than among the general population, is increasing due to recent emphasis on relaxation of regulatory requirements when consistent with safety. GRA

N89-26379# Federal Aviation Administration, Atlantic City, NJ.
AIR TRAFFIC CONTROLLER SCANNING AND EYE MOVEMENTS IN SEARCH OF INFORMATION: A LITERATURE REVIEW Technical Report, Jun. - Dec. 1988
Earl S. Stein Mar. 1989 30 p
(AD-A206709; DOT/FAA/CT-TN89/9) Avail: NTIS HC A03/MF A01 CSCL 01/5

The Federal Aviation Administration is engaged in an on-going research effort designed to help air traffic controllers reduce the frequency of operational errors. This literature search and review was a first step in the study of controller scanning for information. Results indicate that the study of eye movement is a very complex process even given the current technology available. Another finding is that there has been very little accomplished in the study of air traffic controllers scanning and eye movements. The field is wide open and the potential benefits are large. GRA

N89-26380# Texas Univ., Dallas. Center for Communication Disorders.
THE EFFECTS OF BLAST TRAUMA (IMPULSE NOISE) ON HEARING: A PARAMETRIC STUDY, PART 1 Final Report, 15 Sep. 1983 - 31 Dec. 1985
Roger P. Hamernik, William A. Ahroon, and George A. Turrentine 21 Jul. 1988 246 p Prepared in cooperation with State Univ. of New York Coll., Plattsburgh
(Contract DAMD17-83-G-9555)
(AD-A206765; ARL-86-2-Pt-1) Avail: NTIS HC A11/MF A01 CSCL 06/10

There are three broad goals to this project. The first and primary goal is to begin the systematic development of a database from which one could estimate the hazards to hearing resulting from exposure to blast waves or other high level impulse noise transients. To achieve this primary objective the following two objectives must first be achieved: (1) to develop a methodology to efficiently acquire data ona large number of experimental animals that have been exposed to a variety variables; (2) to develop a set of blast wave simulation devices which can reliably generate blast waves with a variable distribution of spectral energy in an environment. This report will describe progress that was achieved on each of these objectives. The evaluation of hearing consisted of pre- and postexposure measurements of pure tone thresholds and tuning curves (masked thresholds). Quantitative and qualitative

data on each experimental cochlea was obtained from the traditional surface preparation technique. GRA

N89-26381# Texas Univ., Dallas. Center for Communication Disorders.
THE EFFECTS OF BLAST TRAUMA (IMPULSE NOISE) ON HEARING: A PARAMETRIC STUDY, PART 2 Final Report, 15 Sep. 1983 - 31 Dec. 1985
Roger P. Hamernik, William A. Ahroon, and George A. Turrentine 21 Jul. 1988 209 p Prepared in cooperation with State Univ. of New York Coll., Plattsburgh
(Contract DAMD17-83-G-9555)
(AD-A206766; ARL-86-2-Pt-2) Avail: NTIS HC A10/MF A01 CSCL 06/10

There are three broad goals to this project. The first and primary goal is to begin the systematic development of a data base from which one could estimate the hazards to hearing resulting from exposure to blast waves or other high level impulse noise transients. To achieve this primary objective the following two objectives must first be achieved: (1) to develop a methodology to efficiently acquire data on a large number of experimental animals that have been exposed to a variety variables; (2) to develop a set of blast wave simulation devices which can reliably generate blast waves with a variable distribution of spectral energy in a laboratory environment. This report will describe progress that was achieved on each of these objectives. The evaluation of hearing consisted of pre- and postexposure measurements of pure tone thresholds and tuning curves (masked thresholds). Quantitative and qualitative preparation technique. GRA

N89-26382# Kansas Univ., Lawrence. Dept. of Speech, Language and Hearing.
DEMODULATION PROCESSES IN AUDITORY PERCEPTION Final Annual Report, 1 Dec. 1987 - 30 Nov. 1989
Lawrence L. Feth 3 Jan. 1989 29 p Prepared in cooperation with Ohio State Univ., Columbus
(Grant AF-AFOSR-0091-87; AF Proj. 2313)
(AD-A207131; AFOSR-89-0468TR) Avail: NTIS HC A03/MF A01 CSCL 06/4

The overall goal of this project is to understand the ability of the human listener to extract information from complex, time-varying sounds such as speech, music or other environmentally important signals. Specifically, we are interested in the listener's ability to process modulations of frequency and amplitude which are thought to carry the information in such signals. To that end we have devised a signal-processing model that calculates the Envelope-Weighted Average of the Instantaneous Frequency (EWAIF) for complex, time-varying signals. We initiated a series of experiments to test the performance of the new EWAIF model. Listeners were asked to discriminate between two frequency modulated tones. Testing of normal listeners in the frequency glide vs multiple-step transition task has indicated that the normal ear has a temporal window of approximately 7 to 10 msec. Further, these results appear to indicate that the critical band, thought to be ubiquitous in peripheral processing, has no effect on the listeners' discriminations of sub-critical, critical or supra-critical bandwidth swept frequency signals. GRA

N89-26383# School of Aerospace Medicine, Brooks AFB, TX.
EVALUATION OF THE SLEEPY CREWMEMBER: USAFSAM EXPERIENCE AND A SUGGESTED CLINICAL APPROACH Interim Report, Nov. 1987 - Apr. 1988
Marc S. Katchen and Gary S. Gronseth Mar. 1989 6 p
(AD-A207151; USAFSAM-JA-88-27) Avail: NTIS HC A02/MF A01 CSCL 05/8

From 1958 to 1986, 27 crewmembers with suspected sleep disorders were referred to the USAF School of Aerospace Medicine. The presenting complaint in most cases was excessive daytime sleepiness (EDS). Prior to 1984, evaluations included neurologic and psychiatric testing, screening laboratory studies, and awake and asleep electroencephalography. Polysomnography and sleep latency studies were included after 1984. In the majority of cases, the etiology of the complaint could not be determined. The prevalence of EDS is estimated to be between 0.3 percent and 4.0 percent of the adult population. Major causes cited in the world literature include the sleep apnea syndromes, narcolepsy, parasomnias interrupting sleep, hypersomnia secondary to systemic or affective disorders, and essential hypersomnia. Current sleep lab techniques and Human Leukocyte Antigen (HLA) typing are reported to make the diagnosis in up to 90 percent of sleep disorders. Evaluation of EDS should begin with a history emphasizing sleep habits, work schedules, daytime naps, and presence of vegetative signs. A sleep diary will allow a more accurate estimate of the quantity of nocturnal sleep. This diary may reveal poor sleep hygiene or insomnia. Polysomnography and/or multiple sleep latency determination can then be used to diagnose sleep apnea, parasomnias, and narcolepsy. GRA

N89-26384# Hebrew Univ., Jerusalem (Israel). Inst. of Physics.
LOW FIRING RATES: AN EFFECTIVE HAMILTONIAN FOR EXCITATORY NEURONS
A. Treves and Daniel J. Amit (Rome Univ., Italy) 16 Jan. 1989 36 p Submitted for publication Sponsored in part by th United States-Israel Binational Science Foundation Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-652; ETN-89-94726) Avail: NTIS HC A03/MF A01

The behavior of an attractor neural network is analyzed. It exhibits low mean temporal activity levels, despite the fact that the intrinsic neuronal cycle time is very short (2 to 3 ms). An effective model, which describes the interplay of excitation and inhibition acting on excitatory neurons in terms of the excitatory neural variables alone is presented. It is argued that quadratic inhibitions can represent in an effective way both the different dynamical characteristics of inhibitory neurons and the nonlinear operation of inhibitory synapses. ESA

53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

N89-26385# Systems Research Labs., Inc., Dayton, OH.
THE USE OF PSYCHOPHYSIOLOGICAL MEASURES IN THE SABER LABORATORIES, PHASE 1 Interim Report, Nov. 1987 - Aug. 1988
Kathy McCloskey, Melodie Morrow, and William A. Perez 3 Oct. 1988 68 p
(Contract F33615-85-C-0541)
(AD-A206825; AAMRL-TR-88-052) Avail: NTIS HC A04/MF A01 CSCL 05/8

Behavioral and psychophysiological measures were obtained during a low-fidelity F-15 flight simulation where subjects were required to fly the wing position in relation to a canned lead flight. One of the major emphases of this preliminary research effort was to identify, solve and document the hardware/software problems that emerged when a physiological data collection device (the Neuropsychological Workload Test Battery) was interface with a computer controlling the simulation (Silicon Graphics device). Another emphasis was determining the cost-effectiveness of psychophysiological measurement in term of value of the data. This study demonstrated that heart rate and eyeblink data not only confirmed and further clarified information obtained by the behavioral measure, but also provided information about the flight task not otherwise available. It was concluded that, in future SABER simulations, the extra costs of collecting physiological data are offset by the increased dimensionality and extra information added to the flight profile database. GRA

N89-26386# California Univ., Berkeley. Dept. of Psychology.
VISUAL INFORMATION-PROCESSING IN THE PERCEPTION OF FEATURES AND OBJECTS Annual Report No. 2, 1 Jan. - 31 Dec. 1988
Anne Treisman 5 Jan. 1989 157 p

(Grant AF-AFOSR-0125-87; AF Proj. 2313)
(AD-A206948; AFOSR-89-0403TR) Avail: NTIS HC A08/MF A01 CSCL 05/8

This research supported by my grant from AFOSR this year completed some of the projects outlined in the first annual report and initiated some new ones. The focus remained on the visual processing of features and objects, the role of spatial attention and the representation of complex visual patterns in perception and memory. Studies of visual search explored the coding of features at potentially more abstract levels than simple luminance filters: Among the features studied were orientation (for lines, dot pairs and edges), orientation and size (for shapes whose boundaries were defined by discontinuities of texture, motion and depth), and illusory contours. Another series of experiments tested the mechanisms underlying the coding of feature conjunctions, using evidence from search latencies and illusory conjunction errors. The results led to a proposed revision of my earlier feature integration theory. Two other studies looked at memory for visual patterns. One studied the effects of prolonged practice (thousands of trials) on the coding of visual patterns. At the other extreme, an experiment explored the effects on memory just one to five presentations of similar patterns. In both cases, we found striking specificity in the coding of these meaningless shapes and in their effects on subjects' later experiences with the same stimuli. GRA

N89-26387# California Univ., Irvine. Computational Intelligence Project.
RULES AND PRINCIPLES IN COGNITIVE DIAGNOSIS Interim Report, 1 Jan. - 31 Dec. 1988
Pat Langley, James Wogulis, and Stellan Ohlsson (Pittsburgh Univ., PA.) 1 Jan. 1989 37 p
(Contract N00014-85-K-0373)
(AD-A207041; UCI-ICS-TR-89-02; TR-6) Avail: NTIS HC A03/MF A01 CSCL 12/9

Cognitive simulation is concerned with constructing process models of human cognitive behavior. The authors' work on the ACM (Automated Cognitive Modeler) is an attempt to automate this process. The basic assumption is that all goal-oriented cognitive behavior involves search through some problem space. Within this framework, the task of cognitive diagnosis is to identify the problem space in which the subject is operating, identify solution paths used by the subject, and find conditions on the operators that explain those solution paths that predict the subject's behavior on new problems. The work presented in this paper uses techniques from machine learning to automate the tasks of finding solution paths and operator conditions. The authors apply this method to the domain of multi-column subtraction and present results that demonstrate ACM's ability to model incorrect subtraction strategies. Finally, they discuss the difference between procedural bugs and misconceptions, proposing that errors due to misconceptions can be viewed as violations of principles for the task domain. GRA

N89-26388# South Carolina Univ., Columbia. Dept. of Psychology.
WORKING MEMORY CAPACITY: AN INDIVIDUAL DIFFERENCES APPROACH Final Report, 1 Jan. 1987 - 30 Dec. 1988
Randall W. Engle 27 Feb. 1989 23 p
(Grant AF-AFOSR-0069-87; AF Proj. 2313)
(AD-A207127; AFOSR-89-0464TR) Avail: NTIS HC A03/MF A01 CSCL 05/8

A research program is described which addresses several issues about the role of individual differences in working memory and reading comprehension. The studies show a strong positive relationship between measures of working memory capacity and higher level measures of comprehension. More importantly, this relationship does not require that the working memory measure be a form of the comprehension measure. At least one variable known to be important in simple word span, word length, is also important to the complex working memory measures used here and elsewhere and this has important implications for theories about the link between working memory and higher level tasks, at least those of a verbal nature. GRA

N89-26389# Virginia Univ., Charlottesville. Dept. of Psychology.
PERCEPTUAL CONSTRAINTS ON UNDERSTANDING PHYSICAL DYNAMICS Final Report, 1 Jun. 1987 - 31 Dec. 1988
Dennis R. Proffitt and David L. Gilden 28 Feb. 1989 35 p
(Grant AF-AFOSR-0238-88; AF Proj. 2313)
(AD-A207129; AFOSR-89-0452TR) Avail: NTIS HC A03/MF A01 CSCL 05/8

When making dynamical judgments, effective use can be made of one salient dimension of information present in the event. Dynamical judgments are not made by deriving multidimensional quantities. Thus, the adequacy of dynamical judgments depends on the degree of dimensionality that is both: (1) inherent in the physics of the event, and (2) presumed to be present by the observer. Support for this proposal was found in studies of dynamical understandings of wheels, volume displacements (Archimedes Principle), the surface orientation of liquids, and collisions. Additional support was found in a review of the Intuitive Physics literature. Finally, studies of apparent motion indicate that the basic representation of object motions is not dynamical. GRA

N89-26390 Politecnico di Milano (Italy). Laboratorio di Calcolatori.
MODELING HUMAN BEHAVIOR FOR EFFECTIVE PERSON-MACHINE INTERFACES: KNOWLEDGE REPRESENTATION ISSUES
Andrea Bonarini Mar. 1989 17 p
(Rept-89-032; ETN-89-94973) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

The importance of modeling human behavior in order to build Person-Machine Interfaces (PMI) behaving in a suitable way is discussed. It is argued that a PMI not only has to be able to manage a user model, but it must behave as a human being, too. The most effective way to obtain that is to build a PMI based on the same model used to represent human behavior. The PANDA computer system, based on these principles and working on the pragmatic aspects of person-machine dialog, is presented. Knowledge representation and inference are discussed. An example showing the characteristics of this system is outlined. The PANDA is implemented in COMMON LISP and CLOS. ESA

54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

N89-26391*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
HUMAN FACTORS WORKPLACE CONSIDERATIONS
Richard F. Haines Oct. 1988 23 p
(Contract NASw-4234)
(NASA-CR-185400; NAS 1.26:185400; RIACS-TR-88.36) Avail: NTIS HC A03/MF A01 CSCL 05H

Computer workstations assume many different forms and play different functions today. In order for them to assume the effective interface role which they should play they must be properly designed to take into account the ubiguitous human factor. In addition, the entire workplace in which they are used should be properly configured so as to enhance the operational features of the individual workstation where possible. A number of general human factors workplace considerations are presented. This ongoing series of notes covers such topics as achieving comfort and good screen visibility, hardware issues (e.g., mouse maintenance), screen symbology features (e.g., labels, cursors, prompts), and various miscellaneous subjects. These notes are

presented here in order to: (1) illustrate how one's workstation can be used to support telescience activities of many other people working within an organization, and (2) provide a single complete set of considerations for future reference. Author

N89-26392*# Behavioral Health Systems, Inc., Ossining, NY.
VOICE MEASURES OF WORKLOAD IN THE ADVANCED FLIGHT DECK Final Report
Sid J. Schneider, Murray Alpert, and Richard ODonnell Washington Aug. 1989 70 p
(Contract NAS1-18278)
(NASA-CR-4249; NAS 1.26:4249) Avail: NTIS HC A04/MF A01 CSCL 05H

Voice samples were obtained from 14 male subjects under high and low workload conditions. Acoustical analysis of the voice suggested that high workload conditions can be revealed by their effects on the voice over time. Aircrews in the advanced flight deck will be voicing short, imperative sentences repeatedly. A drop in the energy of the voice, as reflected by reductions in amplitude and frequency over time, and the failure to achieve old amplitude and frequency levels after rest periods, can signal that the workload demands of the situation are straining the speaker. This kind of measurement would be relatively unaffected by individual differences in acoustical measures. Author

N89-26393*# ST Systems Corp., Lanham, MD.
IMPEDANCE HAND CONTROLLERS FOR INCREASING EFFICIENCY IN TELEOPERATIONS
Craig Carignan and Janice Tarrant 1989 10 p Presented at the 1989 NASA Conference on Space Telerobotics, Pasadena, CA
(Contract NAS5-28561)
(NASA-CR-183431; NAS 1.26:183431) Avail: NTIS HC A02/MF A01 CSCL 05H

An impedance hand controller with direct force feedback is examined as an alternative to bilateral force reflection in teleoperations involving force contact. Experimentation revealed an operator preference for direct force feedback which provided a better feel of contact with the environment. The advantages of variable arm impedance were also made clear in tracking tests where subjects preferred the larger hand controller inertias made possible by the acceleration feedback loop in the master arm. The ability to decouple the hand controller impedance from the slave arm dynamics is expected to be even more significant when the inertial properties of various payloads in the slave arm are considered. Author

N89-26394# Systems Research Labs., Inc., Dayton, OH.
DEMONSTRATION OF PHYSIOLOGICAL WORKLOAD CORRELATES IN CREW CAPABILITY SIMULATION Interim Report, Nov. 1987 - Dec. 1988
Kathy McCloskey, Melodie Morrow, and William A. Perez 3 Jan. 1989 71 p
(Contract F33615-85-C-0541)
(AD-A206824; AAMRL-TR-89-002) Avail: NTIS HC A04/MF A01 CSCL 05/8

A laboratory physiological measurement device was modified for use in part-mission, multicrew main-in-the-loop simulation experiments. An abstract flight simulation task was employed to obtain behavioral and physiological measures (heart rate, eyeblink, and evoke potentials) which were correlated to achieve an understanding of crew workload. The two classes of workload measures were shown to be relatable and complementary. The modified Neurophysiological Workload Test Battery device was demonstrated to be suitable for use in long duration, manned simulation experiment. GRA

N89-26395# Naval Ocean Systems Center, San Diego, CA.
TELETOUCH DISPLAY DEVELOPMENT, PHASE 1 Final Report, Oct. - Dec. 1987
Steven F. Wiker Jul. 1988 66 p
(AD-A206919; NOSC/TR-1230) Avail: NTIS HC A04/MF A01 CSCL 12/9

Teleoperated manipulators currently in use rely mainly upon visual feedback to accomplish simple manipulation tasks. In some cases, to enhance manipulative capabilities, force reflection and positional correspondence are provided between slave manipulator and master controller arms, along with simple end-effector proximity and slip sensors. However, as noted by Bejczy, space-station assembly, satellite servicing in orbit, extraplanetary exploration, and undersea operations (which require only seemingly ordinary manipulative capabilities) can overwhelm present teleoperated capabilities. To extend telemanipulative capabilities and applications, proposals have been made to improve the quality of current visual, proprioceptive, and kinesthetic feedback. Yet, without feeding back end-effector surface contact phenomena to the teleoperator, remote systems are difficult to field that possess a high degree of dextrous manipulative and haptic abilities. This report reviews human-tactual capabilities and previous efforts in tactile-display development, and recommends approaches for developing teletouch display systems for telerobotic systems. GRA

N89-26396# Navy Clothing and Textile Research Facility, Natick, MA.
EFFECTIVENESS OF THREE PORTABLE COOLING SYSTEMS IN REDUCING HEAT STRESS Final Technical Report, Feb. - Aug. 1988
Nancy A. Pimental and Barbara A. Avellini Mar. 1989 19 p
(AD-A206959; NCTRF-176) Avail: NTIS HC A03/MF A01 CSCL 05/8

The Navy Clothing & Textile Research Facility (NCTRF) conducted a laboratory evaluation to examine a battery-operated, circulating liquid cooling vest and two passive, frozen gel pack vests for their effectiveness in reducing heat strain. The battery-operated system was the Model 1905 Cool Vest, manufactured by ILC Dover, Inc. (ILC). The passive systems were the SteeleVest, manufactured by Steele, Inc. (STEELE), and the Stay Cool Vest, manufactured by American Vest Co. (AMERICAN). Eight test subjects attempted four heat exposures, one without cooling (CONTROL) and one with each of the three cooling systems. The ILC and the STEELE, were similarly effective in reducing heat strain. The AMERICAN, reduced rectal temperature compared with the CONTROL, but not skin temperature, heart rate or sweat rate. The AMERICAN was not nearly as effective as the other two systems, possibly because of its lower surface area available for cooling and poor contact between the torso and the gel packs. Each of the cooling systems has logistical concerns. The ILC requires battery storage and recharging. The STEELE, however, requires more freezer space than the ILC for its coolant. If the added freezer space is not a limiting factor, the STEELE system, because of its simplicity, ease of use and low profile, is recommended for shipboard use. GRA

N89-26397# Naval Submarine Medical Research Lab., Groton, CT.
MODULATION-RATE PERCEPTION: IDENTIFICATION AND DISCRIMINATION OF MODULATION RATE USING A NOISE CARRIER Technical Report, Oct. 1987 - Oct. 1988
Thomas E. Hanna 30 Jan. 1989 24 p
(AD-A207078; NSMRL-1128) Avail: NTIS HC A03/MF A01 CSCL 05/8

Modulation-rate thresholds were measured for three tasks: a fixed-standard, forced-choice discrimination task with a 500-ms interstimulus interval; a random-standard, forced-choice discrimination task with an 8-sec interstimulus interval; and an identification task. Thresholds were obtained for modulation rates from 14 to 224 Hz with noise carriers band-pass filtered from 500 to 4000 Hz, 500 to 1600 Hz, 1700 to 2800 Hz, and 2900 to 4000 Hz. The four bands yielded similar results except for modulation rates of 150 Hz and greater, where the 500 to 1600 Hz thresholds were higher. Fixed-standard discrimination thresholds were a relatively constant 3 Hz for modulation rates up to 66 Hz. The increase of thresholds for modulation rates above 66 Hz could be due to temporal resolution limits with a time constant of about 2.4 msec. For modulation rates above 100 Hz, critical-band filtering

decreases sensitivity to modulation rate for the 500 to 1600 Hz noise band. Resolution in the random-standard discrimination task was similar to that for the identification task. Thresholds were elevated relative to fixed-standard thresholds except at the edges of the stimulus range. In the random-standard discrimination task, a pronounced criterion bias was present for stimuli near the edge of the range. Durlach & Braida's (1969) model describes the data well and provides quantitative measures in good agreement with those for intensity perception. GRA

N89-26398*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
RESULTS AND APPLICATIONS OF A SPACE SUIT RANGE-OF-MOTION STUDY
Al Reinhardt Jul. 1989 16 p Presented at the SAE Intersociety Conference on Environmental Systems, Moffett Field, CA, 24-27 Jul. 1989
(NASA-TM-102204; A-89164; NAS 1.15:102204) Avail: NTIS HC A03/MF A01 CSCL 05H

The range of motion of space suits has traditionally been described using limited 2-D mapping of limb, torso, or arm movements performed in front of an orthogonal grid. A new technique for recovering extra-vehicular (EVA) space suit range-of-motion data during underwater testing was described in a paper presented by the author at the 1988 conference. The new technique uses digitized data which is automatically acquired from video images of the subject. Three-dimensional trajectories are recovered from these data, and can be displayed using 2-D computer graphics. Results of using this technique for the current shuttle EVA suit during underwater simulated weightlessness testing are discussed. Application of the data for use in animating anthropometric computer models is highlighted. Author

N89-26532*# Massachusetts Inst. of Tech., Cambridge.
ISSUES IN HUMAN/COMPUTER CONTROL OF DEXTEROUS REMOTE HANDS
K. Salisbury *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 351-360 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 05H

N89-26533*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MAN-MACHINE INTERFACE ISSUES IN SPACE TELEROBOTICS: A JPL RESEARCH AND DEVELOPMENT PROGRAM
A. K. Bejczy *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 361-369 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 05H

N89-26540*# Stanford Univ., CA.
REPORT ON THE STANFORD/AMES DIRECT-LINK SPACE SUIT PREHENSOR
J. W. Jameson and Larry Leifer *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 433-442 Sponsored by NASA. Ames Research Center (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 05H

55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

N89-26336*# Hebrew Univ., Jerusalem (Israel). Dept. of Soil and Water Science.
VIKING BIOLOGY EXPERIMENTS AND THE MARTIAN SOIL Abstract Only
Amos Banin *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 6 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26337*# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia). Div. of Continental Geology.
MICROBIAL MATS IN PLAYA LAKES AND OTHER SALINE HABITATS: EARLY MARS ANALOG? Abstract Only
John Bauld *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 7-8 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26366*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VIKING AND MARS ROVER EXOBIOLOGY Abstract Only
D. E. Schwartz, Rocco L. Mancinelli, and B. J. OHara *In its* Exobiology and Future Mars Missions Mar. 1989 p 54 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

N89-26367*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MARS ROVER SAMPLE RETURN: A SAMPLE COLLECTION AND ANALYSIS STRATEGY FOR EXOBIOLOGY Abstract Only
M. H. Sims, M. Fischler, D. E. Schwartz, Donald A. Rosenthal, Rocco L. Mancinelli, Susan S. Nedell, E. Gamble, and Christopher P. McKay *In its* Exobiology and Future Mars Missions Mar. 1989 p 55 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

N89-26368*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ELECTRON SPIN RESONANCE (ESR) DETECTION OF ACTIVE OXYGEN SPECIES AND ORGANIC PHASES IN MARTIAN SOILS
Fun-Dow Tsay, Soon Sam Kim, and Ranty H. Liang *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 56-58 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

N89-26370*# Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
FOSSIL LIFE ON MARS
M. R. Walter *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 60-61 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 06C

59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

No abstracts in this category.

60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

N89-26399# Continuous Electron Beam Accelerator Facility, Newport New, VA.
MICROPROCESSOR CONTROL FOR THE CEBAF RF CONTROL MODULE

Isaac Ashkenazi and George E. Lahti 1989 6 p
(Contract DE-AC05-84ER-40150)
(CEBAF-PR-89-009) Avail: NTIS HC A02/MF A01

The Continuous Electron Beam Accelerator Facility (CEBAF) radio frequency (RF) system is controlled by an array of local control computers set in a network and supervised by a central RF system supervisory computer. Each local computer, geographically located near a cluster of 32 klystrons in one service building above the accelerator tunnel, controls the parameters of these klystrons. The RF control module constitutes the control link between the local computer and the individual klystron and RF chain. The communication between the RF Module and the local computer is achieved through CAMAC. The microprocessor section of the RF control module is reviewed. The way it reduces the load on the local RF computer by providing tight closed loop control over the RF chain that it is assigned to is explained. Both the hardware and the software aspects of the subject are covered. Author

N89-26400* National Aeronautics and Space Administration. Pasadena Office, CA.
PROGRAMMABLE PIPELINED IMAGE PROCESSOR Patent
Donald B. Gennery, inventor (to NASA) and Brian Wilcox, inventor (to NASA) 6 Dec. 1988 13 p Filed 31 Dec. 1985 Supersedes N86-23283 (24-13, p 2183)
(Contract NAS7-918)
(NASA-Case-NPO-16461-1CU; US-Patent-4,790,026; US-Patent-Appl-SN-815103; US-Patent-Class-382-49; US-Patent-Class-382-41; US-Patent-Class-382-42; US-Patent-Class-364-131) Avail: U.S. Patent and Trademark Office CSCL 09B

A pipelined image processor selectively interconnects modules in a column of a two-dimensional array to modules of the next column of the array of modules 1,1 through M,N, where M is the number of modules in one dimension and N is the number of modules in the other direction. Each module includes two input selectors for A and B inputs, two convolvers, a binary function operator, a neighborhood comparison operator which produces an A output and an output selector which may select as a B output the output of any one of the components in the module, including the A output of the neighborhood comparison operator. Each module may be connected to as many as eight modules in the next column, preferably with the majority always in a different row that is up (or down) in the array for a generally spiral data path around the torus thus formed. The binary function operator is implemented as a look-up table addressed by the most significant 8 bits of each 12-bit argument. The table output includes a function value and the slopes for interpolation of the two arguments by multiplying the 4 least significant bits in multipliers and adding the products to the function value through adders.
Official Gazette of the U.S. Patent and Trademark Office

N89-26401# National Inst. of Standards and Technology, Boulder, CO. Center for Computing and Applied Mathematics.
ANALYSIS OF COMPUTER PERFORMANCE DATA
Jack C. M. Wang, John Gary, M. (Colorado State Univ., Fort Collins.), and Hari K. Iyer Jan. 1989 45 p
(PB89-162614; NISTIR-88/4019) Avail: NTIS HC A03/MF A01 CSCL 09B

An analysis of the data from the Livermore loops benchmark is presented. It is shown that in a general predictive sense the dimension of this data is rather small; perhaps between two and five. Two techniques are used to reduce the 72 loop timings for each machine to a few scores which characterize the machine. The first is based on a principal component analysis, the second on a cluster analysis of the loops. The validity of the reduction of the data to a lesser dimension is checked by various methods.
Author

N89-26402*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
KANERVA'S SPARSE DISTRIBUTED MEMORY: AN ASSOCIATIVE MEMORY ALGORITHM WELL-SUITED TO THE CONNECTION MACHINE
David Rogers Nov. 1988 21 p Sponsored by DARPA
(Contracts NCC2-408; NCC2-387)
(NASA-CR-185417; NAS 1.26:185417; RIACS-TR-88.32) Avail: NTIS HC A03/MF A01 CSCL 09B

The advent of the Connection Machine profoundly changes the world of supercomputers. The highly nontraditional architecture makes possible the exploration of algorithms that were impractical for standard Von Neumann architectures. Sparse distributed memory (SDM) is an example of such an algorithm. Sparse distributed memory is a particularly simple and elegant formulation for an associative memory. The foundations for sparse distributed memory are described, and some simple examples of using the memory are presented. The relationship of sparse distributed memory to three important computational systems is shown: random-access memory, neural networks, and the cerebellum of the brain. Finally, the implementation of the algorithm for sparse distributed memory on the Connection Machine is discussed.
Author

N89-26403*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
MEMORY PROTECTION
Peter J. Denning 21 Jul. 1988 14 p Submitted for publication
(Contract NCC2-387)
(NASA-CR-184961; NAS 1.26:184961; RIACS-TR-88.17) Avail: NTIS HC A03/MF A01 CSCL 09B

Accidental overwriting of files or of memory regions belonging to other programs, browsing of personal files by superusers, Trojan horses, and viruses are examples of breakdowns in workstations and personal computers that would be significantly reduced by memory protection. Memory protection is the capability of an operating system and supporting hardware to delimit segments of memory, to control whether segments can be read from or written into, and to confine accesses of a program to its segments alone. The absence of memory protection in many operating systems today is the result of a bias toward a narrow definition of performance as maximum instruction-execution rate. A broader definition, including the time to get the job done, makes clear that cost of recovery from memory interference errors reduces expected performance. The mechanisms of memory protection are well understood, powerful, efficient, and elegant. They add to performance in the broad sense without reducing instruction execution rate. Author

N89-26404# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
USING TRANSPUTERS IN FINITE ELEMENTS CALCULATIONS: A FIRST APPROACH
Jose Sergio R. AlvesFilho and D. R. J. Owen Oct. 1988 27 p Presented at the 7th OCCAM Users Group and Workshop on Parallel Programming of Transputer Based Machines, Grenoble, France, 14-16 Sep. 1987
(INPE-4717-PRE/1396) Avail: NTIS HC A03/MF A01

The use of a transputer system for finite element calculations is considered. A parameter study of a processor farm scheme is undertaken and the results are used to develop program TRANSA1 for the explicit transient dynamics problem. Some results are presented showing that a transputer machine can be a fast desk-top solution for running FE programs. Author

N89-26405# Environmental Research Inst. of Michigan, Ann Arbor.
PERFORMANCE ANALYSIS OF THE DAP-610 (TRADEMARK) (ACTIVE MEMORY TECHNOLOGY'S DISTRIBUTED ARRAY PROCESSOR) AS A DATA COMPRESSION PROCESSOR IN A REAL-TIME REMIDS SYSTEM Technical Report, Nov. 1988 - Mar. 1989
L. M. Przebienda 31 Mar. 1989 29 p

(Contract DAAK70-88-C-0032)
(AD-A206587; ERIM-209700-1-T) Avail: NTIS HC A03/MF A01 CSCL 12/6

An analysis of the DAP-610 (Active Memory Technology's Distributed Array Processor) was undertaken to determine if the DAP-610 is capable of functioning as a major system component in a real-time processor. The evaluated functions required of the DAP-610 include: a direct link to an external multispectral sensor sending 16-bit data at a 1.65MHz rate, demultiplexing and reformatting of sensor data, data compression processing, feature extraction, VMEbus input/output for communication with other system components, and output of high resolution image data for display. The DAP-610 was found to be capable of all these functions. However, processing time estimates available are insufficient to verify that the implementations will operate within the real time constraints. GRA

N89-26406# Rochester Univ., NY. Dept. of Computer Science.
LEXICAL ANALYSIS ON A MODERATELY SIZED MULTIPROCESSOR
James R. Low Oct. 1988 23 p
(Contract DACA76-85-C-0001; NSF DCR-83-20136)
(AD-A206657; TR-261) Avail: NTIS HC A03/MF A01 CSCL 12/6

In the past few years, several computing systems have been developed which use traditional Von-Neuman processors executing in parallel. These processors communicate at speeds which are only slightly slower than accesses to local memory. Communication is accomplished using message passing and/or shared memory techniques. These computers are described as MIMD (Multiple Instruction Multiple Data) machines. We use the term Moderately Sized Multiprocessor to describe MIMD systems which contain a moderate number (several dozen) processors. Examples of such systems include the Cal Tech Cosmic-Cube, the NYU UltraComputer, the IBM, and the BBN Butterfly Computer. In this document a method for using dozens of conventional VonNueman processors to tokenize programs in parallel is described. Results of a prototype implementation on the BBN Butterfly Computer are discussed. GRA

N89-26407# Westinghouse Defense and Electronic Systems Center, Baltimore, MD. Development and Operations Div.
GUIDANCE INSTRUCTION SET ARCHITECTURE: MISSILE COMPUTING POWER FOR THE 90'S Technical Paper, Sep. 1987 - Jan 1989
Debra L. Harto and George W. York Feb. 1989 9 p
(Contract F08635-87-C-0107)
(AD-A206962; AFATL-TR-89-01) Avail: NTIS HC A02/MF A01 CSCL 17/7

With the ever increasing processing demands placed on weapon systems, current general purpose processors cannot meet the throughput requirements. Also, processors optimized for executing applications implemented in the DOD mandated language, Ada are necessary. However, a balance between customized hardware and off-the-shelf convenience must be sought. Such a balance is being pursued in the Guidance Set Architecture (GISA) program sponsored by the Air Force Armament Laboratory. In the GISA program, an instruction set architecture optimized for processing tactical missile guidance and control algorithms written in Ada is being developed using off-the-shelf products to the maximum extent possible. This paper provides a description of the program's goals, objective, and accomplishments as well as possible plans for future efforts in this area. GRA

N89-26408# Yale Univ., New Haven, CT.
A NEURAL NETWORK APPROACH TO MODEL-BASED RECOGNITION Annual Report, 1 Dec. 1987 - 1 Dec. 1988
Gene R. Gindi 1 Feb. 1989 34 p
(Contract F49620-88-C-0025)
(AD-A206990; AFOSR-89-0445TR) Avail: NTIS HC A03/MF A01 CSCL 12/9

The problem of recognizing structured patterns (object recognition) is being pursued on several fronts. The main thrust of the work involves the design of networks that store some notion of a relational model of an object and performs recognition via a version of graph matching. This approach is governed by the use of objective functions to both specify the network and the problem to be solved. The dynamics of the net thus carry out an optimization procedure. Key here is the incorporation into the objective function of compositional and specialization hierarchy of models, and provision to perform dynamic grouping (perceptual organization) of the input data. Results so far show very good performance for versions where data is preprocessed into a form matchable to the database, but poorer performance on more difficult problems where the network must itself organize raw data into relational structures for matching. A related effort explores aspects of traditional associative memories that may be of use in more complex networks. Questions of performance, storage and robustness are addressed. A new fast learning algorithms is proposed for a CMAC network. Work in optical implementation of some of these networks constitutes a third front. The main problem here is to use optics to form a fixed interconnection network between layers of 2-D nodes (neurons). Two means of using spatial multiplexing to effect a 4-D interconnect between two 2-D node planes are used: multifaceted holograms multichannel incoherent image systems. GRA

N89-26409# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Electrical and Computer Engineering.
HIGH DENSITY ION IMPLANTED CONTIGUOUS DISK BUBBLE TECHNOLOGY Final Scientific Report, 30 Sep. 1984 - 29 Sep. 1988
Paul H. L. Rasky, Allen Bruce Cowen, Kathy R. Nitzberg, and Michael Alex 31 Mar. 1989 430 p
(Grant AF-AFOSR-0341-83; AF Proj. 2305)
(AD-A207018; AFOSR-89-0476TR) Avail: NTIS HC A19/MF A01 CSCL 09/1

The main thrust of research carried out under this program was to develop high density ion-implanted contiguous-disk bubble memory devices. These devices offer order of magnitude higher bit density than presently manufactured bubble memory devices for a given lithographic resolution. In one phase of the research, a computer simulator was constructed and used to model the operation of ion-implanted contiguous-disk bubble devices. Input parameters for the simulator include the geometry of the implanted patterns, magnetic characteristics of the bubble film, implanted layer thickness, conductor geometry, amplitude and phase of currents in conductors, and the frequency and amplitude of the drive field. The fields acting upon the bubble include those from the conductors, implanted/unimplanted boundaries and charged walls. Using the model, the operation of various gates for ion-implanted devices was analyzed, including a trapping transfer gate and a dual conductor block replicate gate. A novel true swap gate for ion-implanted bubble devices was also devised and simulated. The simulated bias margins of both propagation structures and gates were found to correspond well with experimental measurements. GRA

N89-26410# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
VISUALIZATION OF MULTISPECTRAL IMAGES IN GRAPHIC SYSTEMS [VISUALIZACAO DE IMAGENS MULTIESPECTRAIS EM SISTEMAS GRAFICOS]
Leonardo SantAnnaBins, Ricardo Cartaxo ModestodeSouza, and Guaraci Jose Erthal Dec. 1988 6 p In PORTUGUESE; ENGLISH summary Presented at the 5th Brazilian Symposium on Remote Sensing, Natal, RN, 11-15 Oct. 1988
(INPE-4751-PRE/1424) Avail: NTIS HC A02/MF A01

Many raster graphics systems, mainly used in computer aided design, have display devices with architectures not suited to show multispectral imagery obtained from satellites. One of the factors that affect data visualization is the number of simultaneous colors allowed generally ranging from 16 to 256 chosen from a large palette. A satellite image with 3 spectral bands and 8 bits per pixel can achieve more than 16 million colors theoretically. An efficient algorithm is shown whose purpose is to identify up to

256 most predominant colors within a multispectral image and that allows data visualization with a low cost in the visual quality in many cases. Author

N89-26411# Stanford Univ., CA. Center for Integrated Systems.
SPIM (STANFORD PIPELINED ITERATIVE MULTIPLIER): A PIPELINED 64 X 64 BIT ITERATIVE MULTIPLIER
Mark R. Santoro and Mark A. Horowitz 10 Nov. 1988 33 p
(Contracts MDA903-83-C-0335; N00014-87-K-0828)
(AD-A207200) Avail: NTIS HC A03/MF A01 CSCL 09/1

A 64 by 64 bit iterating multiplier, Stanford Pipelined Iterative Multiplier (SPIM) is presented. The pipelined array consists of a small tree of 4:2 adders. The 4:2 tree is better suited than a Wallace tree for a VLSI implementation because it is a more regular structure. A 4:2 carry save accumulator at the bottom of the array is used to iteratively accumulate partial products, allowing a partial array to be used, which reduces area. SPIM was fabricated in a 1.6 micron CMOS process. It has a core size of 3.8 X 6.5 mm and contains 41 thousand transistors. The on chip clock generator runs at an internal clock frequency of 85 MHz. The latency for a 64 X 64 bit fractional multiply is under 120 ns, with a pipeline rate of one multiply every 47ns. GRA

N89-26412# Technische Univ., Eindhoven (Netherlands). Digital Systems Group.
MINIMAL REALIZATION OF SEQUENTIAL MACHINES: THE METHOD OF MAXIMAL ADJACENCIES
Lech Jozwiak Nov. 1988 99 p
(EUT-88-E-209; ISBN-90-6144-209-5; ISSN-0167-9708;
ETN-89-94797) Avail: NTIS HC A05/MF A01

State assignment for medium and large sequential machines is considered. Two traditionally independent steps: state minimization and state assignment are replaced with a single process of concurrent state minimization and assignment. Minimization (or partial minimization) of internal states is obtained as a byproduct of the state assignment and it results from assigning the same code to two or more internal states. The problem of, in the strict sense, optimal state assignment is unsolved, but approximate approaches are proposed. The method of maximal adjacencies uses much more information about the factors that can have influence on the quality of the resultant assignments than the method of Armstrong and also than all the other related methods. Therefore, in many cases, it can produce better assignments than graph embedding. For the same reason, it can give better assignements than the column based approach. The method presented uses adjacency conditions ordered according to the number of adjacencies reached when a given condition is satisfied by the assignment. The number of adjacencies reflects the condition's quality. Since the conditions are considered and combined, starting with the best, the first assignements constructed are always nearly optimal and, almost always, the best of the nearly optimal solutions is one of the first to be obtained. ESA

N89-26477*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A RUN-TIME CONTROL ARCHITECTURE FOR THE JPL TELEROBOT
J. Balaram, A. Lokshin, K. Kreutz, and J. Beahan *In its* Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 211-221 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26481*# Drexel Univ., Philadelphia, PA.
NESTED HIERARCHICAL CONTROLLER WITH PARTIAL AUTONOMY
A. Meystel *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 251-270 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26484*# Martin Marietta Aero and Naval Systems, Baltimore, MD.
SOLON: AN AUTONOMOUS VEHICLE MISSION PLANNER
M. J. Dudziak *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 289-301 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26503*# Honeywell Systems and Research Center, Minneapolis, MN.
THE ARCHITECTURE OF A VIDEO IMAGE PROCESSOR FOR THE SPACE STATION
S. Yalamanchili, D. Lee, K. Fritze, T. Carpenter, K. Hoyme, and N. Murray (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 85-93 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

N89-26413# Virginia Univ., Charlottesville. Dept. of Computer Science.
IMPLEMENTATION OF A HYPERCUBE DATABASE SYSTEM Annual Report, Jul. 1988 - Feb. 1989
J. L. Pfaltz, S. H. Son, and J. C. French Mar. 1989 31 p
(Contract DE-FG05-88ER-25063)
(DE89-010474; DOE/ER-25063/1; UVA-527387/CS89/101)
Avail: NTIS HC A03/MF A01

At that time the principal investigators had already been working on the development of a database interface that would be appropriate for a hypercube implementation. However, the predominant thrust of that research had been towards developing a semantic data model which has been traditionally viewed as more appropriate for expert and artificial reasoning systems. We realized at that time that such a database implementation would be incomplete unless it also had a full capability for representing and accessing scientific data, by which we commonly mean array data. To support one kind of data without an equivalent capability of supporting all kinds of data would be futile. Still, it required this grant to direct a significant portion of our energies towards the representation of scientific data. In this report, we will concentrate primarily on our efforts to represent array types of data although it can not be entirely separated from our overall goal of representing all types of data in new ways that are particularly appropriate to a parallel processing environment. DOE

N89-26414# National Inst. of Standards and Technology, Gaithersburg, MD. Center for Computing and Applied Mathematics
INTERNAL STRUCTURE OF THE GUIDE TO AVAILABLE MATHEMATICAL SOFTWARE
Ronald F. Boisvert, Sally E. Howe, and Jeanne L. Springmann Mar. 1989 55 p
(PB89-170864; NISTIR-89/4042) Avail: NTIS HC A04/MF A01 CSCL 09B

The purpose of the NIST Guide to Available Mathematical Software (GAMS) project is to provide convenient documentation tools for users and maintainers of scientific computer software. The main components of this effort are a detailed tree-structured, problem-oriented classification scheme for mathematical and statistical software, a printed catalog based upon this classification scheme which integrates information about all available software, an on-line interactive version of this catalog, and a relational database containing all information upon which the on-line and

off-line catalogs rely, along with associated maintenance programs. A detailed specification of the internal structure of the GAMS database and the programs used to manipulate it are presented. The information is useful to those who wish to implement the GAMS systems on their own computer systems. GRA

N89-26415# National Inst. of Standards and Technology, Gaithersburg, MD. Center for Manufacturing Engineering.
A FUNCTIONAL APPROACH TO DESIGNING ARCHITECTURES FOR COMPUTER INTEGRATED MANUFACTURING
Wayne J. Davis (Illinois Univ., Urbana.) and Albert T. Jones Feb. 1989 30 p
(PB89-172589; NISTIR-88/3872) Avail: NTIS HC A03/MF A01 CSCL 09B

Developing effective computer integrated manufacturing (CIM) architecture is hampered by automation and integration problems. The key to resolving these problems lies in a better understanding of each manufacturing function and how it is related to other manufacturing functions. It is proposed that mathematical models can provide this understanding. The results of the initial efforts to develop such models are presented which can be used to guide the development of the technology needed for automation. The results also specify the inputs, outputs, and interrelations needed for integration, regardless of the specific CIM architecture used. GRA

N89-26416*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
KRYLOV SUBSPACE METHODS ON SUPERCOMPUTERS
Youcef Saad Dec. 1988 44 p Submitted for publication
(Contracts NCC2-387; DE-FG02-85ER-25001; NSF MIP-84-10110; NSF DCR-85-09970)
(NASA-CR-185419; NAS 1.26:185419; RIACS-TR-88.40) Avail: NTIS HC A01/MF A01 CSCL 09B

A short survey of recent research on Krylov subspace methods with emphasis on implementation on vector and parallel computers is presented. Conjugate gradient methods have proven very useful on traditional scalar computers, and their popularity is likely to increase as three-dimensional models gain importance. A conservative approach to derive effective iterative techniques for supercomputers has been to find efficient parallel/vector implementations of the standard algorithms. The main source of difficulty in the incomplete factorization preconditionings is in the solution of the triangular systems at each step. A few approaches consisting of implementing efficient forward and backward triangular solutions are described in detail. Polynomial preconditioning as an alternative to standard incomplete factorization techniques is also discussed. Another efficient approach is to reorder the equations so as to improve the structure of the matrix to achieve better parallelism or vectorization. An overview of these and other ideas and their effectiveness or potential for different types of architectures is given. Author

N89-26417*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
TOPOLOGICAL NUMBERING OF FEATURES ON A MESH
Mikhail J. Atallah, Susanne E. Hambrusch, and Lynn E. TeWinkel (Purdue Univ., West Lafayette, IN.) Sep. 1988 12 p Sponsored by AT and T
(Contracts NCC2-387; N0014-84-K-0502; N0014-86-K-0689; NSF DCR-84-51393; NSF MIP-87-15652)
(NASA-CR-185411; NAS 1.26:185411; RIACS-TR-88.25) Avail: NTIS HC A03/MF A01 CSCL 09B

Assume a nxn binary image is given containing horizontally convex features; i.e., for each feature, each of its row's pixels form an interval on that row. The problem of assigning topological numbers to such features is considered; i.e., assign a number to every feature f so that all features to the left of f have a smaller number assigned to them. This problem arises in solutions to the stereo matching problem. A parallel algorithm to solve the topological numbering problem in O(n) time on an nxn mesh of processors is presented. The key idea of the solution is to create a tree from which the topological numbers can be obtained even though the tree does not uniquely represent the to the left of relationship of the features. Author

N89-26418*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
SIMPLIFIED HALF-LIFE METHODS FOR THE ANALYSIS OF KINETIC DATA
J. G. Eberhart (Colorado Univ., Colorado Springs.) and E. Levin Sep. 1988 8 p Submitted for publication
(Contract NCC2-387)
(NASA-CR-185407; NAS 1.26:185407; RIACS-TR-88.24) Avail: NTIS HC A02/MF A01 CSCL 09B

The analysis of reaction rate data has as its goal the determination of the order rate constant which characterize the data. Chemical reactions with one reactant and present simplified methods for accomplishing this goal are considered. The approaches presented involve the use of half lives or other fractional lives. These methods are particularly useful for the more elementary discussions of kinetics found in general and physical chemistry courses. Author

N89-26419*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
BENCHMARKING AND PERFORMANCE ANALYSIS OF THE CM-2
David W. Myers and George B. Adams, II (Purdue Univ., West Lafayette, IN.) Dec. 1988 114 p
(Contract NCC2-387)
(NASA-CR-185406; NAS 1.26:185406; RIACS-TR-88.19) Avail: NTIS HC A06/MF A01 CSCL 09B

A suite of benchmarking routines testing communication, basic arithmetic operations, and selected kernel algorithms written in LISP and PARIS was developed for the CM-2. Experiment runs are automated via a software framework that sequences individual tests, allowing for unattended overnight operation. Multiple measurements are made and treated statistically to generate well-characterized results from the noisy values given by cm:time. The results obtained provide a comparison with similar, but less extensive, testing done on a CM-1. Tests were chosen to aid the algorithmist in constructing fast, efficient, and correct code on the CM-2, as well as gain insight into what performance criteria are needed when evaluating parallel processing machines. Author

N89-26420*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
EVALUATION OF THE DORNIER GMBH INTERACTIVE GRID GENERATION SYSTEM Final Report
Robert L. Brown 7 Feb. 1989 15 p
(Contract NCC2-387)
(NASA-CR-181407; NAS 1.26:181407; RIACS-M-89.1) Avail: NTIS HC A03/MF A01 CSCL 09B

An interactive grid generation program, INGRID, is investigated and evaluated. A description of the task and work performed, a description and evaluation of INGRID, and a discussion of the possibilities for bringing INGRID into the NASA and Numerical Aerodynamic Simulator (NAS) computing environments is included. The interactive grid generation program was found to be a viable approach for grid generation and determined that it could be converted to work in the NAS environment but that INGRID does not solve the fundamentally hard problems associated with grid generation, specifically, domain decomposition. Author

N89-26421*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
COMPUTER VIRUSES
Peter J. Denning 21 Mar. 1988 15 p Submitted for publication
(Contract NCC2-387)
(NASA-CR-184680; NAS 1.26:184680; RIACS-TR-88.10) Avail: NTIS HC A03/MF A01 CSCL 09B

The worm, Trojan horse, bacterium, and virus are destructive programs that attack information stored in a computer's memory.

Virus programs, which propagate by incorporating copies of themselves into other programs, are a growing menace in the late-1980s world of unprotected, networked workstations and personal computers. Limited immunity is offered by memory protection hardware, digitally authenticated object programs,and antibody programs that kill specific viruses. Additional immunity can be gained from the practice of digital hygiene, primarily the refusal to use software from untrusted sources. Full immunity requires attention in a social dimension, the accountability of programmers. Author

N89-26422*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
OUTPUT-SENSITIVE HIDDEN SURFACE ELIMINATION FOR RECTANGLES
Mikhail J. Atallah and Michael T. Goodrich (Johns Hopkins Univ., Baltimore, MD.) Sep. 1988 29 p Sponsored by AT and T
(Contracts NCC2-387; N00014-84-K-0502; N00014-86-K-0689; NSF DCR-84-51393; NSF CCR-88-10568)
(NASA-CR-185426; NAS 1.26:185426; RIACS-TR-88.42) Avail: NTIS HC A03/MF A01 CSCL 09B

An algorithm for the well-known hidden-surface elimination problem for rectangles, which is also known as the window rendering problem is presented. The time complexity of the algorithm is sensitive to the size of the output. Specifically, it runs in time that is O (n(1.5) + k), where k is the size of the output (which can be as large as theta (n(squared)). For values of k in the range between n(1.5)/log n and n squared, the algorithm is asymptotically faster than previous ones. Author

N89-26423*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
SOLVING LARGE SPARSE EIGENVALUE PROBLEMS ON SUPERCOMPUTERS
Bernard Philippe (Institut National de Recherche d'Informatique et d'Automatique, Rennes, France) and Youcef Saad Dec. 1988 21 p Presented at the International Workshop on Parallel Algorithms and Architectures, Bonas, France, Oct. 1988
(Contracts NCC2-387; DAAL03-88-K-0085; DE-FG02-85ER-25001; NSF MIP-84-10110; NSF DCR-85-09970)
(NASA-CR-185421; NAS 1.26:185421; RIACS-TR-88.38) Avail: NTIS HC A03/MF A01 CSCL 09B

An important problem in scientific computing consists in finding a few eigenvalues and corresponding eigenvectors of a very large and sparse matrix. The most popular methods to solve these problems are based on projection techniques on appropriate subspaces. The main attraction of these methods is that they only require the use of the matrix in the form of matrix by vector multiplications. The implementations on supercomputers of two such methods for symmetric matrices, namely Lanczos' method and Davidson's method are compared. Since one of the most important operations in these two methods is the multiplication of vectors by the sparse matrix, methods of performing this operation efficiently are discussed. The advantages and the disadvantages of each method are compared and implementation aspects are discussed. Numerical experiments on a one processor CRAY 2 and CRAY X-MP are reported. Possible parallel implementations are also discussed. Author

N89-26424# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Dept. de Processamento de Imagens.
USING PRIMAL SKETCH PRIMITIVES AS THE BASIS FOR THE HOUGH TRANSFORM
Flavio Roberto DiasVelasco, Antonio Miguel VieiraMonteiro, and Leonardo SantAnnaBins Dec. 1988 10 p Presented at the 2nd International Conference on Computer Vision, FL, 5-8 Dec. 1988
(Contract ESTRA-01.01.035.0/88)
(INPE-4742-PRE/1416) Avail: NTIS HC A02/MF A01

The Hough transform was proposed originally as an efficient way to detect straight lines in images. It has been generalized to detect arbitrary shapes. This generalization made the Hough transform a kind of universal tool for object detection. The use of primal sketch primitives, as defined by Marr, are proposed as the basic elements upon which the transform is constructed (instead of simple edge elements). The advantages of using the primitives are a better discrimination and less computational effort. An algorithm is shown for detecting arbitrary shapes using the primal sketch primitives that deals with the problem of rotation directly, without the need to quantize for possible rotations. Author

N89-26425# Environmental Research Inst. of Michigan, Ann Arbor.
GADS (GRAPHIC ATTITUDE DETERMINATION SYSTEM) ALGORITHM DEVELOPMENT UNDER ENGINEERING ANALYSIS TASK Technical Report, Sep. - Dec. 1988
James W. Sherman Mar. 1989 19 p
(Contract F08635-87-C-0074)
(AD-A206588; ERIM-202000-30-T) Avail: NTIS HC A03/MF A01 CSCL 12/3

Under the Engineering Analysis Task of Contract F08635-87-C-0074, two development efforts pertaining to GADS (Graphic Attitude Determination System) algorithms were pursued. These efforts resulted in two upgrades to the GADS algorithms. The first upgrade resulted from a direct linear algebra solution for the model drawing equations for a body of revolution. The second upgrade resulted from developing an error analysis that is driven by the model being displayed to determine an estimated covariance for the errors in the position and attitude of the model being fit to the displayed image. GRA

N89-26426# Yale Univ., New Haven, CT. Dept. of Computer Science.
A FAST ALGORITHM FOR THE EVALUATION OF LEGENDRE EXPANSIONS
B. Alpert and V. Rokhlin Jan. 1989 29 p
(Contract N00014-86-K-0310)
(AD-A206625; YALEU/DCS/RR-671) Avail: NTIS HC A03/MF A01 CSCL 12/1

An algorithm is presented for a rapid calculation of the values and coefficients of finite Legendre series. Given an n-term Legendre expansion, the algorithm produces its values at n Chebyshev nodes on the interval -1,1 for a cost proportional to n log n. Similarly, given the values of a function f at n Chebyshev nodes, the algorithm produces the n-term Legendre expansion of the polynomial of degree n - 1 that is equal of f at these nodes. The cost of the algorithm is roughly 3 times that of the fast Fourier transform of length n, provided that calculations are performed to single precision accuracy. In double precision, the ratio is approximately 5.5. The method employed admits far-reaching generalizations and is currently being applied to several other problems. GRA

N89-26427# Sabbagh Associates, Inc., Bloomington, IN.
COMPUTER ALGORITHMS AND ARCHITECTURES FOR THREE-DIMENSIONAL EDDY-CURRENT NONDESTRUCTIVE EVALUATION. VOLUME 1: EXECUTIVE SUMMARY Final Report, 2 Dec. 1986 - 20 Jan. 1989
20 Jan. 1989 13 p
(Contract N00019-86-C-0219)
(AD-A206627; SA/TR-2/89-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 12/6

This report develops an electromagnetic model for three-dimensional inversion of eddy-current data, an inversion algorithm based on the conjugate gradient technique, and a special purpose computer that we estimate can execute this algorithm in times comparable to high speed main-frames. This computer has a pipeline architecture and is designed around our parallel implementation of the inversion algorithm and makes use of high-speed DSP chips. The inversion process achieves a higher performance measure when more than one data set is inverted. The sequential order of the inversion scheme restricts the number of active elements in the pipe for a single problem. When more than one inversion problem enters the pipe, then more than one element could be active to improve the overall performance of the system. The basic electromagnetic model starts with integral equations for electromagnetic scattering, which are then discretized

by means of the method of moments. This gives us the fundamental inversion model, which is then solved using the conjugate gradient algorithm. In order to accomplish the three-dimensional inversion, we acquire data at a number of frequencies; therefore, our inversion process is called a multifrequency method. The choice of frequencies, and the number of frequencies to be used, depend upon the conductivity of the host material, and the depth resolution sought. GRA

N89-26428# Sabbagh Associates, Inc., Bloomington, IN.
COMPUTER ALGORITHMS AND ARCHITECTURES FOR THREE-DIMENSIONAL EDDY-CURRENT NONDESTRUCTIVE EVALUATION, VOLUME 2, CHAPTERS 1-5 Final Report, 2 Dec. 1986 - 20 Jan. 1989
20 Jan. 1989 151 p
(Contract N00019-86-C-0219)
(AD-A206628; SA/TR-2/89-Vol-2) Avail: NTIS HC A08/MF A01 CSCL 12/6

An electromagnetic model for three-dimensional inversion of eddy-current data, an inversion algorithm based on the conjugate gradient technique, and a special purpose computer that we estimate can execute this algorithm in times comparable to high speed main-frames was developed. This computer has a pipe architecture and is designed around our parallel implementation of the inversion algorithm and makes use of high-speed DSP chips. The inversion process achieves a higher performance measure when more than one data set is inverted. The sequential order of the inversion scheme restricts the number of active elements in the pipeline for a single problem. When more than one inversion problem enters the pipe, then more than one element could be active to improve the overall performance of the system. The basic electromagnetic model starts with the integral equations for electromagnetic scattering, which are then discretized by means of the method of moments. This gives us the fundamental inversion model, which is then solved using the conjugate gradient algorithm. In order to accomplish the three-dimensional inversion, we acquire data at a number of frequencies; therefore, our inversion process is called a multifrequency method. The choice of frequencies, and the number of frequencies to be used, depend upon the conductivity of the host material, and the depth resolution sought. This volume contitutes chapters 1 through 5. GRA

N89-26429# Sabbagh Associates, Inc., Bloomington, IN.
COMPUTER ALGORITHMS AND ARCHITECTURES FOR THREE-DIMENSIONAL EDDY-CURRENT NONDESTRUCTIVE EVALUATION, VOLUME 3, CHAPTERS 6-11 Final Report, 2 Dec. 1986 - 20 Jan. 1989
20 Jan. 1989 183 p
(Contract N00019-86-C-0219)
(AD-A206629; SA/TR-2/89-Vol-3) Avail: NTIS HC A09/MF A01 CSCL 12/6

This report develops an electromagnetic model for three-dimensional inversion of eddy-current data, an inversion algorithm based on the conjugate gradient technique, and a special purpose computer that we estimate can execute this algorithm in times comparable to high speed main-frames. This computer has a pipeline architecture and is designed around our parallel implementation of the inversion algorithm and makes use of high-speed DSP chips. The inversion process achieves a higher performance measure when more than one data set is inverted. The sequential order of the inversion scheme restricts the number of active elements in the pipe for a single problem. When more than one inversion problem enters the pipe, then more than one element could be active to improve the overall performance of the system. The basic electromagnetic model starts with the integral equations for electromagnetic scattering, which are then discretized by means of the method of moments. The choice of frequencies, and the number of frequencies to be used, depend upon the conductivity of the host material, and the depth resolution sought. GRA

N89-26430# Boston Univ., MA. Center for Adaptive Systems.
NEURAL NETWORK MODELS OF VECTOR CODING, LEARNING, AND TRAJECTORY FORMATION DURING PLANNED AND REACTIVE ARM AND EYE MOVEMENTS Interim Report
Stephen Grossberg Feb. 1989 37 p
(Contracts F49620-86-C-0037; F49620-86-C-0018; NSF IRI-87-16960)
(AD-A206737; AFOSR-89-0430TR) Avail: NTIS HC A03/MF A01 CSCL 23/3

Contemporary neural network models provide insights into some of the organizational principles that govern biological sensory-motor systems, and offer a level of computational precision that enables sharp comparisons and contrasts to be made between different sensory-motor systems. The capacity of these models to clarify, integrate, and predict behavioral and neural data is predicated upon the coordinated use of theoretical, mathematical, computational and empirical tools in a manner that reveals many more constraints on brain design than empirical tools alone. No single experimental paradigm in the behavioral and brain sciences provides sufficiently many data to uniquely characterize a neural system. Interdisciplinary theoretical and empirical approaches that can coordinate and discover both top-down and bottom-up constraints at multiple levels of behavioral and neural organization provide a much greater level of guidance towards characterizing brain designs. The present chapter takes as its point of departure one important design principle that has been clarified by such an interdisciplinary approach. This is the principle of vector encoding that has been described, for example, in both the control of saccadic eye movements by the superior colliculus and the control of arm movements by the motor cortex. GRA

N89-26431# Carlow Associates, Inc., Fairfax, VA.
DETERMINING THE BEST WAY TO REPRESENT COMPUTER FUNCTIONS TO THE USER: TEXT ONLY, GRAPHICS ONLY; OR A MIXTURE OF BOTH
Nov. 1988 278 p
(Contract DAAA15-86-D-0005)
(AD-A206757) Avail: NTIS HC A13/MF A01 CSCL 12/5

Recent advances in computer technology have provided designers with a wide range of alternatives for representing system functions to users. These alternatives range from short command abbreviations to complex english-like statements to graphic symbols. As a result, there has been a proliferation of terminology and interaction modes leading to extreme non-standardization of the user-computer interface. This condition is of particular concern for the Army in that standardization is a necessary prerequisite for minimizing training time and costs, and ensuring inter-system compatibility. Recognizing the potential impact of this situation on system readiness, a research program was initiated to assess the magnitude of the non-standardization problem and to identify trends in the assignment of names, abbreviations, and symbols. As part of that effort, a pilot study was conducted to determine the requirements for conducting a major study to evaluate the relative effectiveness of alternatives modes of function representation. Three modes of representation were selected for the pilot study: text only, graphic only, and mixed (text and graphics). The results of the pilot study are presented. GRA

N89-26432# Air Force Geophysics Lab., Hanscom AFB, MA.
USERS GUIDE TO LOWTRAN 7 Interim Scientific Report
F. X. Kneizys, E. P. Shettle, L. W. Abreu, J. H Chetwynd, G. P. Anderson, W. O. Gallery, J. E. A. Shelby, and S. A. Clough 16 Aug. 1988 146 p
(AD-A206773; AFGL-TR-88-0177; AFGL-ERP-1010) Avail: NTIS HC A07/MF A01 CSCL 12/5

LOWTRAN 7 is a low-resolution propagation model and computer code for predicting atmospheric transmittance and background radiance from 0 to 50,000/cm at a resolution of 20/cm. The code is based on the LOWTRAN 6 (1983) model. Multiple scattered radiation has been added to the model as well as new molecular band model parameters and new ozone and molecular oxygen absorption parameters for the UV. Other modifications

include a wind dependent desert model, new cirrus cloud models, and new cloud and rain models. The code also includes new representative (geographical and seasonal) atmospheric models and updated aerosol models with options to replace them with user-derived values. An improved extra-terrestrial solar source function is also included. Six modes of program execution are allowed with the new model and computer code for a given slant path geometry. This report contains a description to users for operating the LOWTRAN 7 computer code. It summarizes the capabilities of the new code, provides complete operating instructions as well as input and output from test cases for user validation. Also included are operating instructions for three programs that utilize LOWTRAN 7 output (plot, filter and scanning function programs). GRA

N89-26433# Carnegie-Mellon Univ., Pittsburgh, PA. Software Engineering Inst.
PROCEEDINGS OF THE WORKSHOP ON EXECUTIVE SOFTWARE ISSUES Final Report
Richard Martin, Scott Carey, Mark Coticchia, Priscilla Fowler, and John Maher, Jr Jan. 1989 27 p Workshop held in Pittsburgh, PA, 2-3 Aug. 1988 and 18 Nov. 1988
(Contract F19628-85-C-0003)
(AD-A206779; CMU/SEI-89-TR-6; ESD-89-TR-6) Avail: NTIS HC A03/MF A01 CSCL 12/5

These proceedings document the results of two sessions of the Work shop on Executive Software Issues held at the Software Engineering Institute on August 2-3 and November 18, 1988. The purpose of the workshop was to define the issues that should be brought to the attention of executives in the defense industry, government, and academia and to propose resolutions to those issues. The issues discussed were divided into three broad categories: national strategy, acquisition, and building large complex systems. Described in the proceedings are the major issues and recommended actions. GRA

N89-26434# Rochester Univ., NY. Dept. of Computer Science.
REAL-TIME VERGENCE CONTROL
Thomas J. Olson and Robert D. Potter Nov. 1988 23 p
(Contracts DACA76-85-C-0001; N00014-82-K-0193)
(AD-A206853; AD-E501080; TR-264) Avail: NTIS HC A03/MF A01 CSCL 12/9

Binocular robots whose cameras can be independently directed require some mechanism for aiming both cameras at the same world point. We describe a mechanism for verging the cameras of the Rochester Robot in real time. The mechanism consists of a discrete control loop driven by an algorithm that estimates a single disparity from the two cameras. We present two algorithms for disparity estimation. The first uses the cepstral-transform approach of Yeshurun and Schwartz (1987). We argue that in this application the cepstrum is best understood as autocorrelation with an adaptive filter that acts to sharpen peaks in the autocorrelation image. We show that qualitatively similar filters have similar effects, with limiting case being equivalent to deconvolution. We describe efficient real-time implementations of the cepstral and deconvolution approaches. GRA

N89-26435# California Univ., Berkeley. Center for Pure and Applied Mathematics.
COMMUNICATION COST OF SPARSE CHOLESKY FACTORIZATION ON A HYPERCUBE
F. Gao and B. N. Parlett Dec. 1988 15 p
(Contract N00014-85-K-0180)
(AD-A206860; PAM-436) Avail: NTIS HC A03/MF A01 CSCL 12/6

The authors consider the nested dissection ordering of a k x k grid of nodes and the Cholesky factorization of the associated k squared x k squared symmetric matrix. When the factorization is computed on a hypercube machine with p processors then the communication cost (the total number of nonzero elements that need to be communicated among the processors) can be kept down to O (pk squared) when the processors are assigned appropriately. This result was proved in George, Liu and Ng (1987). We offer a simple proof of a slightly stronger result: the communication cost for each processor is O (k squared). Load balancing is built into our proof. Our argument extends to grids in more than 2 dimensions. GRA

N89-26436# Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Computer Science.
RESEARCH ON SIGNAL PROCESSING SUPERCOMPUTERS Final Technical Report, Sep. 1985 - Sep. 1986
H. T. Kung Sep. 1988 48 p
(Contract F30602-81-C-0206)
(AD-A206911; RADC-TR-87-219) Avail: NTIS HC A03/MF A01 CSCL 12/6

Signal processing is an area where the required computational bandwidth in an application can be unbounded. Applications such as radar, sonar and communications already call for signal processing systems capable of delivering billions or tens of billions of operations per second. In developing a new signal processor to meet these requirements, it is essential to understand the underlying computational models. An ad-hoc processor development effort that is unclear on the computational models will likely be wasteful and unable to meet the long-term performance goal. Fortunately, because the control in signal processing is typically data-independent, computational models in this area can be relatively simple. Based on the study performed under this contract, this report describes some important computational models for parallel signal processing, and illustrates how the Warp machine developed by Carnegie Mellon supports these models. GRA

N89-26437# Illinois Univ., Urbana. Dept. of Computer Science.
THE SME (STRUCTURE-MAPPING ENGINE) USER'S MANUAL (SME VERSION 2E)
Brian Falkenhainer 30 Dec. 1988 50 p
(Contracts N00014-85-K-0559; N00014-89-J-1272)
(AD-A207042; UIUCDCS-R-88-1421; UILU-ENG-88-1726) Avail: NTIS HC A03/MF A01 CSCL 12/5

This paper documents the Structure-Mapping Engine (SME), a general-purpose program for studying analogical processing. It provides a comprehensive description of the program and instructions for using it, including techniques for integrating it into larger systems. One section demonstrates methods for configuring SME to a variety of mapping preferences and suggests the range of theoretical variations available. GRA

N89-26438# Air Force Academy, CO. Research Lab.
ESR BASE: AN ELECTRON SPIN RESONANCE SPECTRUM BASELINE CORRECTION ROUTINE USING CHEBYSCHEV POLYNOMIALS Technical Report, Nov. 1988 - Mar. 1989
Joseph A. Menapace Mar. 1989 63 p
(AD-A207065; FJSRL-TR-89-0003) Avail: NTIS HC A04/MF A01 CSCL 07/4

An electron spin resonance (ESR) spectrum baseline correction routine is presented for use in modeling correcting experimental ESR spectral data. The routine corrects for baseline intensity drift by approximating the baseline using a Chebyschev (power-series) polynomial expansion. The correction routine's source code is written in FORTRAN 77 and accepts computerized ESR spectral data as input from files written in ASCII format. After correcting the baseline to zero intensity, the routine outputs ASCII files containing the corrected ESR spectral data, the baseline intensity data, and the Chebyschev coefficients for use in subsequent analyses. The algorithm used to implement the Chebyschev polynomial baseline correction and the utilities needed to perform the calculation are described and serve as a guide to the user for both routine operation and subsequent modification of the computer source code to a particular application. GRA

N89-26439# Connecticut Univ., Storrs. Dept. of Mathematics.
CONVERGENCE AND PERFORMANCE OF SYNCHRONOUS AND ASYNCHRONOUS PARALLEL AND CONVENTIONAL ITERATIVE METHODS Annual Report, 1 Jan. - 31 Dec. 1988
Michael Neumann 28 Feb. 1989 6 p

(Grant AF-AFOSR-0047-88; AF Proj. 2304)
(AD-A207093; Rept-1171-000-22-00211-06-194; AFOSR-89-0327TR) Avail: NTIS HC A02/MF A01 CSCL 12/1

The report is presented in three parts. Part 1: five research projects are briefly described. Resulting reports are attached as appendices. Part 2: The activities are detailed which were undertaken with support of the grant. This includes conferences, talks and consultations. Part 3: The papers are listed which were submitted for publication and which grew out of the work supported by the grant. GRA

N89-26440# Rome Univ. (Italy). Dipartimento di Fisica.
PERCEPTRON BEYOND THE LIMIT OF CAPACITY
P. DelGiudice (Istituto Superiore di Sanita, Rome, Italy), S. Franz, and M. A. Virasoro 18 Jul. 1988 22 p Sponsored in part by the Guggenheim Foundation, NY
(Preprint-612; ETN-89-94699) Avail: NTIS HC A03/MF A01

An input output map in which the patterns are divided into classes is considered for the perceptron. The statistical mechanical analysis with a finite number of classes turns out to give the same results as the case of only one class of patterns. The limit of capacity and the relevant order parameters are calculated in a mean field approach. The analysis is completed with numerical simulations with the perceptron learning rule. ESA

N89-26441# Technische Univ., Eindhoven (Netherlands). Automatic System Design Group.
HARDWARE SYNTHESIS WITH THE AID OF DYNAMIC PROGRAMMING M.S. Thesis
H. vanWoudenberg and R. vandenBorn Jun. 1988 47 p
(EUT-88-E-201; ISBN-90-6144-201-X; ISSN-0167-9708; ETN-89-94789) Avail: NTIS HC A03/MF A01

The automated synthesis of hardware structures from behavioral descriptions is described. The description is first translated to a demand graph. The nodes of this graph describe operations and algorithmic constructs; the edges describe data flow. A dynamic programming based method is used to generate the structure. Dynamic programming is used to restrict the large number of possible implementations by selecting at some intervals the best intermediate structural solutions. The final hardware structure consists of a list of modules and a net-list with the interconnections between the modules. This hardware description is completed with a state machine description. The synthesis program is coded in LISP. Improvements and completions are suggested. The results are encouraging for further research. ESA

N89-26442# Institut Franco-Allemand de Recherches, Saint-Louis (France).
COMPUTER SIMULATED RADIOGRAPHY [RECHNERGESTUETZTE ROENTGENBILDSIMULATION]
T. Ebding 21 Oct. 1987 15 p In GERMAN
(ISL-R-124/87; ETN-89-94857) Avail: NTIS HC A03/MF A01

A computer program for the generation of synthetic radiographic image sequences is described. Body geometry is represented by linear models. Rotation and translation movements can be applied to the models with the variation of technical parameters as follows: X ray dose, X ray absorption by the material, sensitivity of the luminescent screen, and film sensitivity. These synthetic radiographic images can be used in interior or terminal ballistics. ESA

N89-26443# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
AN O(n3L) APPROXIMATE CENTER METHOD FOR LINEAR PROGRAMMING
C. Roos 1988 17 p
(Rept-88-69; ISSN-0922-5641; ETN-89-94900) Copyright Avail: NTIS HC A03/MF A01

A modification of Roos and Vial's (1988) path following algorithm for the solution of the linear programming is presented. It is shown that it requires only O (ncuL) arithmetic operations. ESA

N89-26444# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
ANALYTIC CENTERS IN LINEAR PROGRAMMING
C. Roos and J.-Ph. Vial (Geneva Univ., Switzerland) 1988 16 p
(Grant SNFSR-1-467-0-86)
(Rept-88-74; ISSN-0922-5641; ETN-89-94905) Copyright Avail: NTIS HC A03/MF A01

It is shown that analytic centers in the primal and in the dual of a linear programming problem can be generated from different potentials and that they come by dual pairs. The relation among the parameters, in particular the lower bound and the upper bound, and the primal and dual objective values, is given. An abstract algorithm based on this relation is proposed. It provides a conceptual framework for path following methods. ESA

N89-26445 Politecnico di Milano (Italy). Laboratorio di Calcolatori.
GEKATOO: A GENERAL KNOWLEDGE ACQUISITION TOOL
Andrea Bonarini, Maria Caterina Gallo, and Marco Guida Mar. 1989 15 p
(Rept-89-033; ETN-89-94974) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

A tool supporting a Knowledge Engineer (KE) in the knowledge acquisition process for building Knowledge Based Systems (KBS) is outlined. It is argued that it is impossible to make a machine performing automatically this process, since too many competences should be transferred from the KE to a computer. In order to develop an effective support system, a model of the KE's knowledge is needed. The GEKATOO implements a proposal for such a model, partitioning the expert's knowledge into three areas. The first two are related to the domain of application and the classes of application. The third one enables domain and application independent analysis of the reasoning methods to be used by the KBS to generate new knowledge from the one already present. The result of the application of GEKATOO is a conceptual model of the knowledge needed to implement a KBS solving the task defined by the expert. A prototype of the system was implemented in COMMON LISP and CLOS on Xerox 1186 machines. ESA

N89-26472*# IBM Watson Research Center, Yorktown Heights, NY.
PROGRAMMING METHODOLOGY FOR A GENERAL PURPOSE AUTOMATION CONTROLLER
M. C. Sturzenbecker, J. U. Korein, and R. H. Taylor *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 167-172 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26474*# Indian Inst. of Tech., Madras.
METALEVEL PROGRAMMING IN ROBOTICS: SOME ISSUES
A. KumarN and N. Parameswaran *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 181-185 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26475*# Michigan Univ., Ann Arbor.
AN APPROACH TO DISTRIBUTED EXECUTION OF Ada PROGRAMS
R. A. Volz, P. Krishnan, and R. Theriault *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 187-197 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26476*# Purdue Univ., West Lafayette, IN.
COMPUTATIONAL STRUCTURES FOR ROBOTIC COMPUTATIONS
C. S. G. Lee and P. R. Chang *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics,

Volume 1 1 Jul. 1987 p 199-210 (For primary document see N89-26454 20-63)
(Grant NSF CDR-85-00022)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26480*# Rensselaer Polytechnic Inst., Troy, NY.
SOFTWARE AND HARDWARE FOR INTELLIGENT ROBOTS
G. N. Saridis and K. P. Valavanis (Northeastern Univ., Boston, MA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 241-249 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26489*# Carnegie-Mellon Univ., Pittsburgh, PA.
GEOMETRIC REASONING
R. F. Woodbury and I. J. Oppenheim *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 351-360 (For primary document see N89-26454 20-63)
(EPRI Proj. RP2515-1)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26490*# Michigan Univ., Ann Arbor.
A QUALITATIVE APPROACH FOR RECOVERING RELATIVE DEPTHS IN DYNAMIC SCENES
S. M. Haynes and R. Jain *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 361-367 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

N89-26516*# McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO.
REAL-TIME GRAPHIC SIMULATION FOR SPACE TELEROBOTICS APPLICATIONS
E. W. Baumann *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 207-217 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26522*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A SPACE SYSTEMS PERSPECTIVE OF GRAPHICS SIMULATION INTEGRATION
R. Brown, C. Gott, G. Sabionski, and D. Bochsler (LinCom Corp., Houston, TX.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 267-272 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26525*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SYSTEMS SIMULATIONS SUPPORTING NASA TELEROBOTICS
F. W. Harrison, Jr. and J. E. Pennington *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 293-299 Previously announced in IAA as A87-23227 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26535*# Veterans Administration Hospital, Palo Alto, CA.
A NATURAL-LANGUAGE INTERFACE TO A MOBILE ROBOT
S. Michalowski, C. Crangle, and L. Liang (Stanford Univ., CA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 381-391 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26536*# Stanford Univ., CA.
TYPES OF VERBAL INTERACTION WITH INSTRUCTABLE ROBOTS
C. Crangle, P. Suppes, and S. Michalowski (Veterans Administration Hospital, Palo Alto, CA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 393-402 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26538*# California Univ., Berkeley.
TELEROBOTICS: A SIMULATION FACILITY FOR UNIVERSITY RESEARCH
L. Stark, W. Kim, F. Tendick, M. Tyler, B. Hannaford, W. Barakat, O. Bergengruen, L. Braddi, J. Eisenberg, and S. Ellis et al *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 413-421 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26539*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MIXED-INITIATIVE CONTROL OF INTELLIGENT SYSTEMS
G. C. Borchardt *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 423-432 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26542*# McDonnell-Douglas Research Labs., Saint Louis, MO.
THE MECHANISMS OF TEMPORAL INFERENCE
B. R. Fox and S. R. Green (McDonnell-Douglas Astronautics Co., Cocoa Beach, FL.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 9-15 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26572*# California Univ., Davis.
PARALLEL PROCESSING ARCHITECTURE FOR COMPUTING INVERSE DIFFERENTIAL KINEMATIC EQUATIONS OF THE PUMA ARM
T. C. Hsia, G. Z. Lu, and W. H. Han (Nankai Univ., Tiangjin, China) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 317-324 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26607*# Space Telescope Science Inst., Baltimore, MD.
GENETIC ALGORITHMS APPLIED TO THE SCHEDULING OF THE HUBBLE SPACE TELESCOPE
Jeffrey L. Sponsler *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 391-402 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

N89-26446*# Research Triangle Inst., Research Triangle Park, NC. Center for Digital Systems Research.
DESIGN FOR VALIDATION: AN APPROACH TO SYSTEMS VALIDATION Final Report
William C. Carter, Janet R. Dunham, Jean-Claude Laprie, Thomas Williams, William Howden, Brian Smith, and Carl M. Lewis, ed. May 1989 50 p
(Contract NAS1-17964)
(NASA-CR-181835; NAS 1.26:181835) Avail: NTIS HC A03/MF A01 CSCL 09B

Every complex system built is validated in some manner. Computer validation begins with review of the system design. As systems became too complicated for one person to review, validation began to rely on the application of adhoc methods by

many individuals. As the cost of the changes mounted and the expense of failure increased, more organized procedures became essential. Attempts at devising and carrying out those procedures showed that validation is indeed a difficult technical problem. The successful transformation of the validation process into a systematic series of formally sound, integrated steps is necessary if the liability inherent in the future digita-system-based avionic and space systems is to be minimized. A suggested framework and timetable for the transformtion are presented. Basic working definitions of two pivotal ideas (validation and system life-cyle) are provided and show how the two concepts interact. Many examples are given of past and present validation activities by NASA and others. A conceptual framework is presented for the validation process. Finally, important areas are listed for ongoing development of the validation process at NASA Langley Research Center. Author

N89-26447*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
MASSIVE PARALLELISM IN THE FUTURE OF SCIENCE
Peter J. Denning 11 Nov. 1988 12 p Submitted for publication
(Contract NCC2-387)
(NASA-CR-185416; NAS 1.26:185416; RIACS-TR-88.33) Avail: NTIS HC A03/MF A01 CSCL 09B

Massive parallelism appears in three domains of action of concern to scientists, where it produces collective action that is not possible from any individual agent's behavior. In the domain of data parallelism, computers comprising very large numbers of processing agents, one for each data item in the result will be designed. These agents collectively can solve problems thousands of times faster than current supercomputers. In the domain of distributed parallelism, computations comprising large numbers of resource attached to the world network will be designed. The network will support computations far beyond the power of any one machine. In the domain of people parallelism collaborations among large groups of scientists around the world who participate in projects that endure well past the sojourns of individuals within them will be designed. Computing and telecommunications technology will support the large, long projects that will characterize big science by the turn of the century. Scientists must become masters in these three domains during the coming decade. Author

N89-26448*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
NASA'S UNIQUE NETWORKING ENVIRONMENT
Marjory J. Johnson Nov. 1988 8 p
(Contract NCC2-387)
(NASA-CR-185414; NAS 1.26:185414; RIACS-TR-88.31) Avail: NTIS HC A02/MF A01 CSCL 09B

Networking is an infrastructure technology; it is a tool for NASA to support its space and aeronautics missions. Some of NASA's networking problems are shared by the commercial and/or military communities, and can be solved by working with these communities. However, some of NASA's networking problems are unique and will not be addressed by these other communities. Individual characteristics of NASA's space-mission networking enviroment are examined, the combination of all these characteristics that distinguish NASA's networking systems from either commercial or military systems is explained, and some research areas that are important for NASA to pursue are outlined. Author

N89-26449*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
EFFICIENT PARALLEL ALGORITHMS FOR STRING EDITING AND RELATED PROBLEMS
Alberto Apostolico, Mikhail J. Atallah, Lawrence Larmore, and H. S. McFaddin (Purdue Univ., West Lafayette, IN.) Sep. 1988 31 p Sponsored by IASI-CNR, Rome, Italy and AT and T
(Contract NCC2-387; N00014-84-K-0502; N00014-86-K-0689)
(NASA-CR-185410; NAS 1.26:185410; RIACS-TR-88.26) Avail: NTIS HC A03/MF A01 CSCL 09B

The string editing problem for input strings x and y consists of transforming x into y by performing a series of weighted edit operations on x of overall minimum cost. An edit operation on x can be the deletion of a symbol from x, the insertion of a symbol in x or the substitution of a symbol x with another symbol. This problem has a well known O((absolute value of x)(absolute value of y)) time sequential solution (25). The efficient Program Requirements Analysis Methods (PRAM) parallel algorithms for the string editing problem are given. If m = ((absolute value of x),(absolute value of y)) and n = max((absolute value of x),(absolute value of y)), then the CREW bound is O (log m log n) time with O (mn/log m) processors. In all algorithms, space is O (mn). Author

N89-26450*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
COMPUTER NETWORKS FOR REMOTE LABORATORIES IN PHYSICS AND ENGINEERING
Scott Starks, David Elizandro, Barry M. Leiner, and Michael Wiskerchen (Stanford Univ., CA.) Apr. 1988 10 p Presented at the 1988 ASEE Southeastern Section Conference
(Contract NASw-4234)
(NASA-CR-185403; NAS 1.26:185403; RIACS-TR-88.13) Avail: NTIS HC A02/MF A01 CSCL 09B

This paper addresses a relatively new approach to scientific research, telescience, which is the conduct of scientific operations in locations remote from the site of central experimental activity. A testbed based on the concepts of telescience is being developed to ultimately enable scientific researchers on earth to conduct experiments onboard the Space Station. This system along with background materials are discussed. Author

N89-26451*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
THE PHYSICS OF PARALLEL MACHINES
Tony F. Chan (California Univ., Los Angeles.) Nov. 1988 7 p Presented at the Workshop on Opportunities and Constraints of Parallel Computing, 5-6 Dec. 1988
(Contracts NCC2-387; DE-FG03-87ER-25037)
(NASA-CR-185425; NAS 1.26:185425; RIACS-TR-88.43) Avail: NTIS HC A02/MF A01 CSCL 09B

The idea is considered that architectures for massively parallel computers must be designed to go beyond supporting a particular class of algorithms to supporting the underlying physical processes being modelled. Physical processes modelled by partial differential equations (PDEs) are discussed. Also discussed is the idea that an efficient architecture must go beyond nearest neighbor mesh interconnections and support global and hierarchical communications. Author

N89-26452*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
MULTIPROCESSOR SPEED-UP, AMDAHL'S LAW, AND THE ACTIVITY SET MODEL OF PARALLEL PROGRAM BEHAVIOR
Erol Gelenbe (Paris V Univ., France) Dec. 1988 16 p
(Contract NCC2-387)
(NASA-CR-185422; NAS 1.26:185422; RIACS-TR-88.37) Avail: NTIS HC A03/MF A01 CSCL 09B

An important issue in the effective use of parallel processing is the estimation of the speed-up one may expect as a function of the number of processors used. Amdahl's Law has traditionally provided a guideline to this issue, although it appears excessively pessimistic in the light of recent experimental results. In this note, Amdahl's Law is amended by giving a greater importance to the capacity of a program to make effective use of parallel processing, but also recognizing the fact that imbalance of the workload of each processor is bound to occur. An activity set model of parallel program behavior is then introduced along with the corresponding parallelism index of a program, leading to upper and lower bounds to the speed-up. Author

N89-26453# Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
PARALLEL COMPUTATIONS Ph.D. Thesis
Gerard Zwaan 1989 195 p
(ETN-89-94879) Avail: NTIS HC A09/MF A01
It is shown how communication of values and parallel computations can be described using trace theory as a formalism. It is also shown how programs may be derived from specifications. These programs can be proved to be correct, i.e., they satisfy their specifications, and have neither deadlock nor divergence.
ESA

N89-26511*# California Univ., Davis.
PARALLEL PROCESSING FOR DIGITAL PICTURE COMPARISON
H. D. Cheng and L. T. Kou *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 155-161 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

N89-26584*# Maryland Univ., College Park. Dept. of Computer Science.
PARALLEL PLAN EXECUTION WITH SELF-PROCESSING NETWORKS
C. Lynne DAutrechy and James A. Reggia *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 61-73 (For primary document see N89-26578 20-63)
(Grants NAG1-885; NSF IRI-84-51430)
Avail: NTIS HC A17/MF A01 CSCL 09B

63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

N89-26454*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PROCEEDINGS OF THE WORKSHOP ON SPACE TELEROBOTICS, VOLUME 1
G. Rodriguez, ed. 1 Jul. 1987 365 p Workshop held in Pasadena, CA, 20-22 Jan. 1987; sponsored by NASA, Washington, DC
(NASA-CR-184685; JPL-Publ-87-13-Vol-1; NAS 1.26:184685)
Avail: NTIS HC A16/MF A01 CSCL 09B
These proceedings report the results of a workshop on space telerobotics, which was held at the Jet Propulsion Laboratory, January 20-22, 1987. Sponsored by the NASA Office of Aeronautics and Space Technology (OAST), the Workshop reflected NASA's interest in developing new telerobotics technology for automating the space systems planned for the 1990s and beyond. The workshop provided a window into NASA telerobotics research, allowing leading researchers in telerobotics to exchange ideas on manipulation, control, system architectures, artificial intelligence, and machine sensing. One of the objectives was to identify important unsolved problems of current interest. The workshop consisted of surveys, tutorials, and contributed papers of both theoretical and practical interest. Several sessions were held on the themes of sensing and perception, control execution, operator interface, planning and reasoning, and system architecture. For individual titles, see N89-26455 through N89-26491.

N89-26455*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BUILDING INTELLIGENT SYSTEMS: ARTIFICIAL INTELLIGENCE RESEARCH AT NASA AMES RESEARCH CENTER
P. Friedland and H. Lum *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 19-25 Previously announced in IAA as A88-15300 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B
The basic components that make up the goal of building autonomous intelligent systems are discussed, and ongoing work at the NASA Ames Research Center is described. It is noted that a clear progression of systems can be seen through research settings (both within and external to NASA) to Space Station testbeds to systems which actually fly on the Space Station. The starting point for the discussion is a truly autonomous Space Station intelligent system, responsible for a major portion of Space Station control. Attention is given to research in fiscal 1987, including reasoning under uncertainty, machine learning, causal modeling and simulation, knowledge from design through operations, advanced planning work, validation methodologies, and hierarchical control of and distributed cooperation among multiple knowledge-based systems.
Author

N89-26456*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE TELEROBOTIC SYSTEMS: APPLICATIONS AND CONCEPTS **c37**
L. Jenkins *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 29-34 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I
The definition of a variety of assembly, servicing, and maintenance missions has led to the generation of a number of space telerobot concepts. The remote operation of a space telerobot is seen as a means to increase astronaut productivity. Dexterous manipulator arms are controlled from the Space Shuttle Orbiter cabin or a Space Station module. Concepts for the telerobotic work system have been developed by the Lyndon B. Johnson Space Center through contracts with the Grumman Aerospace Corporation and Marin Marietta Corporation. These studies defined a concept for a telerobot with extravehicular activity (EVA) astronaut equivalent capability that would be controlled from the Space Shuttle. An evolutionary development of the system is proposed as a means of incorporating technology advances. Early flight testing is seen as needed to address the uncertainties of robotic manipulation in space. Space robotics can be expected to spin off technology to terrestrial robots, particularly in hazardous and unstructured applications.
Author

N89-26457*# Boeing Aerospace Co., Huntsville, AL.
LABORATORY TESTING OF CANDIDATE ROBOTIC APPLICATIONS FOR SPACE **c37**
R. B. Purves *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 35-44 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I
Robots have potential for increasing the value of man's presence in space. Some categories with potential benefit are: (1) performing extravehicular tasks like satellite and station servicing, (2) supporting the science mission of the station by manipulating experiment tasks, and (3) performing intravehicular activities which would be boring, tedious, exacting, or otherwise unpleasant for astronauts. An important issue in space robotics is selection of an appropriate level of autonomy. In broad terms three levels of autonomy can be defined: (1) teleoperated - an operator explicitly controls robot movement; (2) telerobotic - an operator controls the robot directly, but by high-level commands, without, for example, detailed control of trajectories; and (3) autonomous - an operator supplies a single high-level command, the robot does all necessary task sequencing and planning to satisfy the command. Researchers chose three projects for their exploration of technology and implementation issues in space robots, one each of the three application areas, each with a different level of autonomy. The projects were: (1) satellite servicing - teleoperated; (2) laboratory assistant - telerobotic; and (3) on-orbit inventory manager -

autonomous. These projects are described and some results of testing are summarized. Author

N89-26458*# Grumman Aerospace Corp., Bethpage, NY. Space Systems Div.
TELEROBOTIC ASSEMBLY OF SPACE STATION TRUSS STRUCTURES **c18**
G. Fischer *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 45-53 Previously announced as N87-18984 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

Discussed here are methods of assembling the space station's structure utilizing only telerobotic devices, i.e.: (1) an approximately anthropomorphic telerobot with two dextrous arms; (2) the Shuttle Remote Manipulator System (SRMS); and (3) various material handling machines. Timelines and task recommendations for autonomous operations are also included. Also described are some experimental results comparing two manipulator control devices. Author

N89-26459*# Lockheed Missiles and Space Co., Sunnyvale, CA.
ROBOTIC MOBILE SERVICING PLATFORM FOR SPACE STATION **c18**
S. H. Lowenthal and L. VanErden *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 55-65 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

The semi-autonomous inspection and servicing of the Space Station's major thermal, electrical, mechanical subsystems are critical needs for the safe and reliable operation of the station. A conceptual design is presented of a self-intelligent, small and highly mobile robotic platform. Equipped with suitable inspection sensors (cameras, ammonia detectors, etc.), this system's primary mission is to perform routine, autonomous inspection of the Station's primary subsystems. Typical tasks include detection of leaks from thermal fluid or refueling lines, as well as detection of micro-meteroid damage to the primary structure. Equipped with stereo cameras and a dexterous manipulator, simple teleoperator repairs and small On-orbit Replacement Unit (ORU) changeout can also be accomplished. More difficult robotic repairs would be left to the larger, more sophisticated Mobile Remote Manipulator System (MRMS). An ancillary function is to ferry crew members and equipment around the station. The primary design objectives were to provide a flexible, but uncomplicated robotic platform, one which caused minimal impact to the design of the Station's primary structure but could accept more advanced telerobotic technology as it evolves. Author

N89-26460*# California Inst. of Tech., Pasadena.
SYSTEM ENGINEERING TECHNIQUES FOR ESTABLISHING BALANCED DESIGN AND PERFORMANCE GUIDELINES FOR THE ADVANCED TELEROBOTIC TESTBED **c14**
W. F. Zimmerman and J. R. Matijevic *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 67-73 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 14B

Novel system engineering techniques have been developed and applied to establishing structured design and performance objectives for the Telerobotics Testbed that reduce technical risk while still allowing the testbed to demonstrate an advancement in state-of-the-art robotic technologies. To estblish the appropriate tradeoff structure and balance of technology performance against technical risk, an analytical data base was developed which drew on: (1) automation/robot-technology availability projections, (2) typical or potential application mission task sets, (3) performance simulations, (4) project schedule constraints, and (5) project funding constraints. Design tradeoffs and configuration/performance iterations were conducted by comparing feasible technology/task set configurations against schedule/budget constraints as well as original program target technology objectives. The final system configuration, task set, and technology set reflected a balanced advancement in state-of-the-art robotic technologies, while meeting programmatic objectives and schedule/cost constraints. Author

N89-26461*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
DEDICATED ROBOTIC SERVICING FOR THE SPACE STATION **c18**
R. F. Thompson, G. Arnold, and D. Gutow *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 75-82 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

The concept of a series of dedicated robotics manipulators that would be resident in the subsystems of the Space Station is presented. These would be used to do Orbital Replacement Unit (ORU) exchanges, inspection of the components, and in certain cases subsystem assembly. By performing these well-definded tasks automatically, higher crew productivity would be achieved. In order to utilize the robots effectively, ORU's must be designed to allow remote release and quick disconnection of the electrical, fluid, and thermal connections. The robot must be of a modular design for ease of maintenance and must have an adaptive control capability to make-up for slight errors in programming. Author

N89-26462*# Martin Marietta Aerospace, Denver, CO.
SHUTTLE BAY TELEROBOTICS DEMONSTRATION **c16**
W. Chun and P. Cogeos *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 83-90 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

A demonstration of NASA's robotics capabilities should be a balanced agenda of servicing and assembly tasks combined with selected key technical experiments. The servicing tasks include refueling and module replacement. Refueling involves the mating of special fluid connectors while module replacement requires an array of robotic technologies such as special tools, the arm of a logistics tool, and the precision mating of orbital replacement units to guides. The assembly task involves the construction of a space station node and truss structure. The technological experiments will focus on a few important issues: the precision manipulation of the arms by a teleoperator, the additional use of several mono camera views in conjunction with the stereo system, the use of a general purpose end effector versus a caddy of tools, and the dynamics involved with using a robot with a stabilizer. Author

N89-26463*# California Univ., Berkeley.
TELEROBOTICS: RESEARCH NEEDS FOR EVOLVING SPACE STATIONS **c18**
L. Stark *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 91-94 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 22B

It is argued that triplicate planning for telerobotics applicable to space stations is needed. It is important to carry out research to accomplish tasks: (1) with man alone (such as extra-vehicular activities), (2) with autonomous robots, and (3) with telerobotics. The research necessary to carry out these approaches is compared and contrasted in order to clarify present problems. Author

N89-26464*# California Univ., Santa Barbara.
ROBOT DESIGN FOR A VACUUM ENVIRONMENT **c37**
S. Belinski, W. Trento, R. Imani-Shikhabadi, and S. Hackwood *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 95-103 Sponsored in part by Delco Systems Operations (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

The cleanliness requirements for many processing and manufacturing tasks are becoming ever stricter, resulting in a

greater interest in the vacuum environment. Researchers discuss the importance of this special environment, and the development of robots which are physically and functionally suited to vacuum processing tasks. Work is in progress at the Center for robotic Systems in Microelectronics (CRSM) to provide a robot for the manufacture of a revolutionary new gyroscope in high vacuum. The need for vacuum in this and other processes is discussed as well as the requirements for a vacuum-compatible robot. Finally, researchers present details on work done at the CRSM to modify an existing clean-room compatible robot for use at high vacuum.
Author

N89-26465*# Ohio State Univ., Columbus.
MULTI-LIMBED LOCOMOTION SYSTEMS FOR SPACE CONSTRUCTION AND MAINTENANCE **c37**
K. J. Waldron and C. A. Klein *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 105-111 (For primary document see N89-26454 20-63)
(Contract NAG1-30; DAAE07-84-K-R001)
Avail: NTIS HC A16/MF A01 CSCL 13I

A well developed technology of coordination of multi-limbed locomotory systems is now available. Results from a NASA sponsored study of several years ago are presented. This was a simulation study of a three-limbed locomotion/manipulation system. Each limb had six degrees of freedom and could be used either as a locomotory grasping hand-holds, or as a manipulator. The focus of the study was kinematic coordination algorithms. The presentation will also include very recent results from the Adaptive Suspension Vehicle Project. The Adaptive Suspension Vehicle (ASV) is a legged locomotion system designed for terrestrial use which is capable of operating in completely unstructured terrain in either a teleoperated or operator-on-board mode. Future development may include autonomous operation. The ASV features a very advanced coordination and control system which could readily be adapted to operation in space. An inertial package with a vertical gyro, and rate gyros and accelerometers on three orthogonal axes provides body position information at high bandwidth. This is compared to the operator's commands, injected via a joystick to provide a commanded force system on the vehicle's body. This system is, in turn, decomposed by a coordination algorithm into force commands to those legs which are in contact with the ground.
Author

N89-26466*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
COMMERCIAL USERS PANEL **c85**
Joseph S. Byrd, Carl Flatau, David C. Hodge, Ralph Hollis, Eugene F. Leach, Ray Gilbert, John Cleland, Larry Leifer, Joseph Naser (Electric Power Research Inst., Palo Alto, CA.), and Samson D. Schmuter et al *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 113-123 Prepared in cooperation with Bureau of Mines, Pittsburgh, PA; Perry Offshore, Riviera Beach, FL; andFord Motor Co., Detroit, MI (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 05A

The discussions of motives and requirements for telerobotics application demonstrated that, in many cases, lack of progress was a result not of limited opportunities but of inadequate mechanisms and resources for promoting opportunities. Support for this conclusion came from Telerobotics, Inc., one of the few companies devoted primarily to telerobot systems. They have produced units for such diverse applications as nuclear fusion research, particle accelerators, cryogenics, firefighting, marine biology/undersea systems and nuclear mobile robotics. Mr. Flatau offered evidence that telerobotics research is only rarely supported by the private sector and that it often presents a difficult market. Questions on the mechanisms contained within the NASA technology transfer process for promoting commercial opportunities were fielded by Ray Gilbert and Tom Walters. A few points deserve emphasis: (1) NASA/industry technology transfer occurs in both directions and NASA recognizes the opportunity to learn a great deal from industry in the fields of automation and robotics; (2) promotion of technology transfer projects takes a demand side approach, with requests to industry for specific problem identification. NASA then proposes possible solutions; and (3) comittment ofmotivated and technically qualified people on each end of a technology transfer is essential.
Author

N89-26467*# University of Southern California, Los Angeles.
TASK ALLOCATION AMONG MULTIPLE INTELLIGENT ROBOTS
L. Gasser and G. Bekey *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 127-130 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Researchers describe the design of a decentralized mechanism for allocating assembly tasks in a multiple robot assembly workstation. Currently, the approach focuses on distributed allocation to explore its feasibility and its potential for adaptability to changing circumstances, rather than for optimizing throughput. Individual greedy robots make their own local allocation decisions using both dynamic allocation policies which propagate through a network of allocation goals, and local static and dynamic constraints describing which robots are elibible for which assembly tasks. Global coherence is achieved by proper weighting of allocation pressures propagating through the assembly plan. Deadlock avoidance and synchronization is achieved using periodic reassessments of local allocation decisions, ageing of allocation goals, and short-term allocation locks on goals.
Author

N89-26468*# Vanderbilt Univ., Nashville, TN.
EXECUTION ENVIRONMENT FOR INTELLIGENT REAL-TIME CONTROL SYSTEMS
Janos Sztipanovits *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 131-138 Sponsored in part by Boeing Aerospace Co.; IBM Corporation; and Vanderbilt Univ. (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Modern telerobot control technology requires the integration of symbolic and non-symbolic programming techniques, different models of parallel computations, and various programming paradigms. The Multigraph Architecture, which has been developed for the implementation of intelligent real-time control systems is described. The layered architecture includes specific computational models, integrated execution environment and various high-level tools. A special feature of the architecture is the tight coupling between the symbolic and non-symbolic computations. It supports not only a data interface, but also the integration of the control structures in a parallel computing environment.
Author

N89-26469*# Martin Marietta Aerospace, Denver, CO.
DISTRIBUTED INTELLIGENCE FOR SUPERVISORY CONTROL
W. J. Wolfe and S. D. Raney *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 139-148 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Supervisory control systems must deal with various types of intelligence distributed throughout the layers of control. Typical layers are real-time servo control, off-line planning and reasoning subsystems and finally, the human operator. Design methodologies must account for the fact that the majority of the intelligence will reside with the human operator. Hierarchical decompositions and feedback loops as conceptual building blocks that provide a common ground for man-machine interaction are discussed. Examples of types of parallelism and parallel implementation on several classes of computer architecture are also discussed.
Author

N89-26470*# FMC Corp., Santa Clara, CA.
AN ARCHITECTURE FOR HEURISTIC CONTROL OF REAL-TIME PROCESSES

P. Raulefs and P. W. Thorndyke *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 149-154 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Abstract Process management combines complementary approaches of heuristic reasoning and analytical process control. Management of a continuous process requires monitoring the environment and the controlled system, assessing the ongoing situation, developing and revising planned actions, and controlling the execution of the actions. For knowledge-intensive domains, process management entails the potentially time-stressed cooperation among a variety of expert systems. By redesigning a blackboard control architecture in an object-oriented framework, researchers obtain an approach to process management that considerably extends blackboard control mechanisms and overcomes limitations of blackboard systems. Author

N89-26471*# National Bureau of Standards, Gaithersburg, MD.
HIERARCHICAL CONTROL OF INTELLIGENT MACHINES APPLIED TO SPACE STATION TELEROBOTS
J. S. Albus, R. Lumia, and H. McCain *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 155-165 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

A hierarchical architecture is described which supports space station telerobots in a variety of modes. The system is divided into three hierarchies: task decomposition, world model, and sensory processing. Goals at each level of the task decomposition hierarchy are divided both spatially and temporally into simpler commands for the next lower level. This decomposition is repeated until, at the lowest level, the drive signals to the robot actuators are generated. To accomplish its goals, task decomposition modules must often use information stored in the world model. The purpose of the sensory system is to update the world model as rapidly as possible to keep the model in registration with the physical world. The architecture of the entire control system hierarchy and how it can be applied to space telerobot applications are discussed. Author

N89-26472*# IBM Watson Research Center, Yorktown Heights, NY.
PROGRAMMING METHODOLOGY FOR A GENERAL PURPOSE AUTOMATION CONTROLLER **c61**
M. C. Sturzenbecker, J. U. Korein, and R. H. Taylor *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 167-172 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

The General Purpose Automation Controller is a multi-processor architecture for automation programming. A methodology has been developed whose aim is to simplify the task of programming distributed real-time systems for users in research or manufacturing. Programs are built by configuring function blocks (low-level computations) into processes using data flow principles. These processes are activated through the verb mechanism. Verbs are divided into two classes: those which support devices, such as robot joint servos, and those which perform actions on devices, such as motion control. This programming methodology was developed in order to achieve the following goals: (1) specifications for real-time programs which are to a high degree independent of hardware considerations such as processor, bus, and interconnect technology; (2) a component approach to software, so that software required to support new devices and technologies can be integrated by reconfiguring existing building blocks; (3) resistance to error and ease of debugging; and (4) a powerful command language interface. Author

N89-26473*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
REAL-TIME HIERARCHICALLY DISTRIBUTED PROCESSING NETWORK INTERACTION SIMULATION
W. F. Zimmerman and C. Wu *In its* Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 173-180 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

The Telerobot Testbed is a hierarchically distributed processing system which is linked together through a standard, commercial Ethernet. Standard Ethernet systems are primarily designed to manage non-real-time information transfer. Therefore, collisions on the net (i.e., two or more sources attempting to send data at the same time) are managed by randomly rescheduling one of the sources to retransmit at a later time interval. Although acceptable for transmitting noncritical data such as mail, this particular feature is unacceptable for real-time hierarchical command and control systems such as the Telerobot. Data transfer and scheduling simulations, such as token ring, offer solutions to collision management, but do not appropriately characterize real-time data transfer/interactions for robotic systems. Therefore, models like these do not provide a viable simulation environment for understanding real-time network loading. A real-time network loading model is being developed which allows processor-to-processor interactions to be simulated, collisions (and respective probabilities) to be logged, collision-prone areas to be identified, and network control variable adjustments to be reentered as a means of examining and reducing collision-prone regimes that occur in the process of simulating a complete task sequence. Author

N89-26474*# Indian Inst. of Tech., Madras.
METALEVEL PROGRAMMING IN ROBOTICS: SOME ISSUES **c61**
A. KumarN and N. Parameswaran *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 181-185 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Computing in robotics has two important requirements: efficiency and flexibility. Algorithms for robot actions are implemented usually in procedural languages such as VAL and AL. But, since their excessive bindings create inflexible structures of computation, it is proposed that Logic Programming is a more suitable language for robot programming due to its non-determinism, declarative nature, and provision for metalevel programming. Logic Programming, however, results in inefficient computations. As a solution to this problem, researchers discuss a framework in which controls can be described to improve efficiency. They have divided controls into: (1) in-code and (2) metalevel and discussed them with reference to selection of rules and dataflow. Researchers illustrated the merit of Logic Programming by modelling the motion of a robot from one point to another avoiding obstacles. Author

N89-26475*# Michigan Univ., Ann Arbor.
AN APPROACH TO DISTRIBUTED EXECUTION OF Ada PROGRAMS **c61**
R. A. Volz, P. Krishnan, and R. Theriault *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 187-197 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Intelligent control of the Space Station will require the coordinated execution of computer programs across a substantial number of computing elements. It will be important to develop large subsets of these programs in the form of a single program which executes in a distributed fashion across a number of processors. A translation strategy for distributed execution of Ada programs in which library packages and subprograms may be distributed is described. A preliminary version of the translator is operational. Simple data objects (no records or arrays as yet), subprograms, and static tasks may be referenced remotely. Author

N89-26476*# Purdue Univ., West Lafayette, IN.
COMPUTATIONAL STRUCTURES FOR ROBOTIC COMPUTATIONS **c61**

C. S. G. Lee and P. R. Chang *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 199-210 (For primary document see N89-26454 20-63)
(Grant NSF CDR-85-00022)
Avail: NTIS HC A16/MF A01 CSCL 09B

The computational problem of inverse kinematics and inverse dynamics of robot manipulators by taking advantage of parallelism and pipelining architectures is discussed. For the computation of inverse kinematic position solution, a maximum pipelined CORDIC architecture has been designed based on a functional decomposition of the closed-form joint equations. For the inverse dynamics computation, an efficient p-fold parallel algorithm to overcome the recurrence problem of the Newton-Euler equations of motion to achieve the time lower bound of O(log sub 2 n) has also been developed. Author

N89-26477*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
A RUN-TIME CONTROL ARCHITECTURE FOR THE JPL TELEROBOT **c60**
J. Balaram, A. Lokshin, K. Kreutz, and J. Beahan *In its* Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 211-221 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

An architecture for implementing the process-level decision making for a hierarchically structured telerobot currently being implemented at the Jet Propolusion Laboratory (JPL) is described. Constraints on the architecture design, architecture partitioning concepts, and a detailed description of the existing and proposed implementations are provided. Author

N89-26478*# TeleRobotics International, Inc., Knoxville, TN.
DISTRIBUTED CONTROL ARCHITECTURE FOR REAL-TIME TELEROBOTIC OPERATION **c37**
H. L. Martin, P. E. Satterlee, Jr., and R. F. Spille *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 223-231 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

The emerging field of telerobotics places new demands on control system architecture to allow both autonomous operations and natural human-machine interfacing. The feasibility of multiprocessor systems performing parallel control computations is realizable. A practical distribution of control processors is presented and the issues involved in the realization of this architecture are discussed. A prototype dual axis controller based on the NOVIX computer is described, and results of its implementation are discussed. Application of this type of control system to a replicated, redundant manipulator system is also described. Author

N89-26479*# Grumman Aerospace Corp., Bethpage, NY.
HIGH PERFORMANCE ARCHITECTURE FOR ROBOT CONTROL **c37**
E. Byler and J. Peterson (Grumann Data Systems Corp., Woodbury, NY.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 233-239 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

Practical aspects of the design and implementation of a modular, high performance, parallel computer control system for telerobots are discussed. Topics of consideration include system architecture, operator interface, and control execution. In a laboratory environment, a telerobotics test control configuration is used to obtain measurements on communications and control loop timing for use in an effective full scale operational system design. The feasibility of the selected architectural approach has been successfully demonstrated. The modularity of the software and hardware enables ease of transport for use in the operational system. The distributed partioning of the control algorithms and the performance measurements acquired during control system implementation are discussed. Author

N89-26480*# Rensselaer Polytechnic Inst., Troy, NY.
SOFTWARE AND HARDWARE FOR INTELLIGENT ROBOTS **c61**
G. N. Saridis and K. P. Valavanis (Northeastern Univ., Boston, MA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 241-249 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Various architectures and their respective software for Hierarchically Intelligent Robots are discussed. They conform to the Principle of Increasing Precision with Decreasing Intelligence by following a three-level structure. The architecture of the organization and coordination levels is presented here and their algorithms are outlined. Author

N89-26481*# Drexel Univ., Philadelphia, PA.
NESTED HIERARCHICAL CONTROLLER WITH PARTIAL AUTONOMY **c60**
A. Meystel *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 251-270 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

The problem of computer architecture for intelligent robots with partial autonomy is addressed. A robot with partial autonomy is considered a degenerated case of a fully autonomous robot. Thus, the problem of man-machine communication is formulated, and the conditions are determined for generating a language for such a communication. The duties of the master are determined. Author

N89-26482*# Oak Ridge National Lab., TN.
THE 3-D WORLD MODELING WITH UPDATING CAPABILITY BASED ON COMBINATORIAL GEOMETRY **c37**
M. Goldstein, F. G. Pin, G. deSaussure, and C. R. Weisbin *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 273-282 Previously announced as N87-20643 Sponsored in part by Nuclear Research Centre, Negev, Israel (For primary document see N89-26454 20-63)
(Contract DE-AC05-84OR-21400)
Avail: NTIS HC A16/MF A01 CSCL 13I

A 3-D world modeling technique using range data is discribed. Range data quantify the distances from the sensor focal plane to the object surface, i.e., the 3-D coordinates of discrete points on the object surface are known. The approach proposed herein for 3-D world modeling is based on the Combinatorial Geometry (CG) method which is widely used in Monte Carlo particle transport calculations. First, each measured point on the object surface is surrounded by a small sphere with a radius determined by the range to that point. Then, the 3-D shapes of the visible surfaces are obtained by taking the (Boolean) union of all the spheres. The result is an unambiguous representation of the object's boundary surfaces. The pre-learned partial knowledge of the environment can be also represented using the CG Method with a relatively small amount of data. Using the CG type of representation, distances in desired directions to boundary surfaces of various objects are efficiently calculated. This feature is particularly useful for continuously verifying the world model against the data provided by a range finder, and for integrating range data from successive locations of the robot during motion. The efficiency of the proposed approach is illustrated by simulations of a spherical robot in a 3-D room in the presence of moving obstacles and inadequate prelearned partial knowledge of the environment. Author

N89-26483*# Louisiana State Univ., Baton Rouge.
ON AUTONOMOUS TERRAIN MODEL ACQUISTION BY A MOBILE ROBOT
N. S. V. Rao, S. S. Iyengar, and C. R. Weisbin (Oak Ridge National

Lab., TN.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 283-288 Previously announced as N87-23964 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

The following problem is considered: A point robot is placed in a terrain populated by an unknown number of polyhedral obstacles of varied sizes and locations in two/three dimensions. The robot is equipped with a sensor capable of detecting all the obstacle vertices and edges that are visible from the present location of the robot. The robot is required to autonomously navigate and build the complete terrain model using the sensor information. It is established that the necessary number of scanning operations needed for complete terrain model acquisition by any algorithm that is based on scan from vertices strategy is given by the summation of i = 1 (sup n) N(O sub i)-n and summation of i = 1 (sup n) N(O sub i)-2n in two- and three-dimensional terrains respectively, where O = (O sub 1, O sub 2,....O sub n) set of the obstacles in the terrain, and N(O sub i) is the number of vertices of the obstacle O sub i. Author

N89-26484*# Martin Marietta Aero and Naval Systems, Baltimore, MD.
SOLON: AN AUTONOMOUS VEHICLE MISSION PLANNER **c60**
M. J. Dudziak *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 289-301 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

The State-Operator Logic Machine (SOLON) Planner provides an architecture for effective real-time planning and replanning for an autonomous vehicle. The highlights of the system, which distinguish it from other AI-based planners that have been designed previously, are its hybrid application of state-driven control architecture and the use of both schematic representations and logic programming for the management of its knowledge base. SOLON is designed to provide multiple levels of planning for a single autonomous vehicle which is supplied with a skeletal, partially-specified mission plan at the outset of the vehicle's operations. This mission plan consists of a set of objectives, each of which will be decomposable by the planner into tasks. These tasks are themselves comparatively complex sets of actions which are executable by a conventional real-time control system which does not perform planning but which is capable of making adjustments or modifications to the provided tasks according to constraints and tolerances provided by the Planner. The current implementation of the SOLON is in the form of a real-time simulation of the Planner module of an Intelligent Vehicle Controller (IVC) on-board an autonomous underwater vehicle (AUV). The simulation is embedded within a larger simulator environment known as ICDS (Intelligent Controller Development System) operating on a Symbolics 3645/75 computer. Author

N89-26485*# FMC Corp., Santa Clara, CA.
MISSION PLANNING FOR AUTONOMOUS SYSTEMS
G. Pearson *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 303-306 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

Planning is a necessary task for intelligent, adaptive systems operating independently of human controllers. A mission planning system that performs task planning by decomposing a high-level mission objective into subtasks and synthesizing a plan for those tasks at varying levels of abstraction is discussed. Researchers use a blackboard architecture to partition the search space and direct the focus of attention of the planner. Using advanced planning techniques, they can control plan synthesis for the complex planning tasks involved in mission planning. Author

N89-26486*# Carnegie-Mellon Univ., Pittsburgh, PA.
CERTAINTY GRIDS FOR MOBILE ROBOTS **c37**
H. P. Moravec *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 307-312 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 13I

A numerical representation of uncertain and incomplete sensor knowledge called Certainty Grids has been used successfully in several mobile robot control programs, and has proven itself to be a powerful and efficient unifying solution for sensor fusion, motion planning, landmark identification, and many other central problems. Researchers propose to build a software framework running on processors onboard the new Uranus mobile robot that will maintain a probabilistic, geometric map of the robot's surroundings as it moves. The certainty grid representation will allow this map to be incrementally updated in a uniform way from various sources including sonar, stereo vision, proximity and contact sensors. The approach can correctly model the fuzziness of each reading, while at the same time combining multiple measurements to produce sharper map features, and it can deal correctly with uncertainties in the robot's motion. The map will be used by planning programs to choose clear paths, identify locations (by correlating maps), identify well-known and insufficiently sensed terrain, and perhaps identify objects by shape. The certainty grid representation can be extended in the same dimension and used to detect and track moving objects. Author

N89-26487*# Advanced Decision Systems, Mountain View, CA.
ENVIRONMENTAL MODELING AND RECOGNITION FOR AN AUTONOMOUS LAND VEHICLE **c37**
D. T. Lawton, T. S. Levitt, C. C. McConnell, and P. C. Nelson *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 313-336 (For primary document see N89-26454 20-63)
(Contract DACA78-85-C-0005)
Avail: NTIS HC A16/MF A01 CSCL 13I

An architecture for object modeling and recognition for an autonomous land vehicle is presented. Examples of objects of interest include terrain features, fields, roads, horizon features, trees, etc. The architecture is organized around a set of data bases for generic object models and perceptual structures, temporary memory for the instantiation of object and relational hypotheses, and a long term memory for storing stable hypotheses that are affixed to the terrain representation. Multiple inference processes operate over these databases. Researchers describe these particular components: the perceptual structure database, the grouping processes that operate over this, schemas, and the long term terrain database. A processing example that matches predictions from the long term terrain model to imagery, extracts significant perceptual structures for consideration as potential landmarks, and extracts a relational structure to update the long term terrain database is given. Author

N89-26488*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TELEROBOT TASK PLANNING AND REASONING: INTRODUCTION TO JPL ARTIFICIAL INTELLIGENCE RESEARCH
D. J. Atkinson *In its* Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 339-350 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

A view of the capabilities and areas of artificial intelligence research which are required for autonomous space telerobotics extending through the year 2000 is given. In the coming years, JPL will be conducting directed research to achieve these capabilities, as well as drawing heavily on collaborative efforts conducted with other research laboratories. Author

N89-26489*# Carnegie-Mellon Univ., Pittsburgh, PA.
GEOMETRIC REASONING **c61**
R. F. Woodbury and I. J. Oppenheim *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 351-360 (For primary

document see N89-26454 20-63)
(EPRI Proj. RP2515-1)
Avail: NTIS HC A16/MF A01 CSCL 09B

Cognitive robot systems are ones in which sensing and representation occur, from which task plans and tactics are determined. Such a robot system accomplishes a task after being told what to do, but determines for itself how to do it. Cognition is required when the work environment is uncontrolled, when contingencies are prevalent, or when task complexity is large; it is useful in any robotic mission. A number of distinguishing features can be associated with cognitive robotics, and one emphasized here is the role of artificial intelligence in knowledge representation and in planning. While space telerobotics may elude some of the problems driving cognitive robotics, it shares many of the same demands, and it can be assumed that capabilities developed for cognitive robotics can be employed advantageously for telerobotics in general. The top level problem is task planning, and it is appropriate to introduce a hierarchical view of control. Presented with certain mission objectives, the system must generate plans (typically) at the strategic, tactical, and reflexive levels. The structure by which knowledge is used to construct and update these plans endows the system with its cognitive attributes, and with the ability to deal with contingencies, changes, unknowns, and so on. Issues of representation and reasoning which are absolutely fundamental to robot manipulation, decisions based upon geometry, are discussed here, not AI task planning per se. Author

N89-26490*# Michigan Univ., Ann Arbor.
A QUALITATIVE APPROACH FOR RECOVERING RELATIVE DEPTHS IN DYNAMIC SCENES **c61**
S. M. Haynes and R. Jain *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 361-367 (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 09B

This approach to dynamic scene analysis is a qualitative one. It computes relative depths using very general rules. The depths calculated are qualitative in the sense that the only information obtained is which object is in front of which others. The motion is qualitative in the sense that the only required motion data is whether objects are moving toward or away from the camera. Reasoning, which takes into account the temporal character of the data and the scene, is qualitative. This approach to dynamic scene analysis can tolerate imprecise data because in dynamic scenes the data are redundant. Author

N89-26491*# New York Univ., New York.
A FRAMEWORK FOR QUALITATIVE REASONING ABOUT SOLID OBJECTS
E. Davis *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 369-375 (For primary document see N89-26454 20-63)
(Grants NSF DCR-84-02309; NSF DCR-86-03758)
Avail: NTIS HC A16/MF A01 CSCL 09B

Predicting the behavior of a qualitatively described system of solid objects requires a combination of geometrical, temporal, and physical reasoning. Methods based upon formulating and solving differential equations are not adequate for robust prediction, since the behavior of a system over extended time may be much simpler than its behavior over local time. A first-order logic, in which one can state simple physical problems and derive their solution deductively, without recourse to solving the differential equations, is discussed. This logic is substantially more expressive and powerful than any previous AI representational system in this domain. Author

N89-26492*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PROCEEDINGS OF THE WORKSHOP ON SPACE TELEROBOTICS, VOLUME 2
G. Rodriguez, ed. 1 Jul. 1987 422 p Workshop held in Pasadena, CA, 20-22 Jan. 1987; sponsored by NASA, Washington, DC
(NASA-CR-184686; JPL-Publ-87-13-Vol-2; NAS 1.26:184686)
Avail: NTIS HC A18/MF A01 CSCL 09B

Research on sensing and perception, telerobots, man machine interface, scheduling, trajectory planning for manipulators, and manipulator control is discussed. For individual titles, see N89-26493 through N89-26540.

N89-26493*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE SENSING AND PERCEPTION SUBSYSTEM OF THE NASA RESEARCH TELEROBOT **c37**
B. Wilcox, D. B. Gennery, B. Bon, and T. Litwin *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 3-7 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

A useful space telerobot for on-orbit assembly, maintenance, and repair tasks must have a sensing and perception subsystem which can provide the locations, orientations, and velocities of all relevant objects in the work environment. This function must be accomplished with sufficient speed and accuracy to permit effective grappling and manipulation. Appropriate symbolic names must be attached to each object for use by higher-level planning algorithms. Sensor data and inferences must be presented to the remote human operator in a way that is both comprehensible in ensuring safe autonomous operation and useful for direct teleoperation. Research at JPL toward these objectives is described. Author

N89-26494*# Honeywell Systems and Research Center, Minneapolis, MN.
KNOWLEDGE-BASED VISION FOR SPACE STATION OBJECT MOTION DETECTION, RECOGNITION, AND TRACKING
P. Symosek, D. Panda, S. Yalamanchili, and W. Wehner, III *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 9-18 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Computer vision, especially color image analysis and understanding, has much to offer in the area of the automation of Space Station tasks such as construction, satellite servicing, rendezvous and proximity operations, inspection, experiment monitoring, data management and training. Knowledge-based techniques improve the performance of vision algorithms for unstructured environments because of their ability to deal with imprecise a priori information or inaccurately estimated feature data and still produce useful results. Conventional techniques using statistical and purely model-based approaches lack flexibility in dealing with the variabilities anticipated in the unstructured viewing environment of space. Algorithms developed under NASA sponsorship for Space Station applications to demonstrate the value of a hypothesized architecture for a Video Image Processor (VIP) are presented. Approaches to the enhancement of the performance of these algorithms with knowledge-based techniques and the potential for deployment of highly-parallel multi-processor systems for these algorithms are discussed. Author

N89-26495*# Rockwell International Science Center, Thousand Oaks, CA.
SENSOR SYSTEMS TESTBED FOR TELEROBOTIC NAVIGATION **c04**
A. W. Thiele, D. E. Gjellum, R. H. Rattner, and D. Manouchehri (Rockwell International Corp., Downey, CA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 19-21 (For primary document see N89-26492 20-63)
(Contract NAS9-17365)
Avail: NTIS HC A18/MF A01 CSCL 17G

A testbed has been developed for the study of sensor systems to be used in telerobotic operations. The program, conducted in conjunction with Johnson Space Center of NASA, addresses the navigational problems associated with target acquisition and rendezvous for teleoperated robotic work stations. The program

will utilize a mobile platform which will support various sensor systems during their development and testing in an earth-based environment. The testbed has been developed in support of a program to develop sensor systems that will aid in rendezvous and docking operations to be conducted as a part of the space station program. A mobile platform has been used to permit testing of these components in a conventional laboratory environment with consequent savings in cost and complexity. The sensor systems, while representative of devices currently in use for robotic applications, are not considered prototypical of the ones that will be used in the final applications. The test program provided information that will support the design of system augmentations and will lead to a comprehensive test program for sensor development. Author

N89-26496*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MONOVISION TECHNIQUES FOR TELEROBOTS c74
P. W. Goode and K. Carnils *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 23-29 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 20F

The primary task of the vision sensor in a telerobotic system is to provide information about the position of the system's effector relative to objects of interest in its environment. The subtasks required to perform the primary task include image segmentation, object recognition, and object location and orientation in some coordinate system. The accomplishment of the vision task requires the appropriate processing tools and the system methodology to effectively apply the tools to the subtasks. The functional structure of the telerobotic vision system used in the Langley Research Center's Intelligent Systems Research Laboratory is discussed as well as two monovision techniques for accomplishing the vision subtasks. Author

N89-26497*# Minnesota Univ., Minneapolis.
TRACKING 3-D BODY MOTION FOR DOCKING AND ROBOT CONTROL
M. Donath, B. Sorensen, G. B. Yang, and R. Starr *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 31-43 (For primary document see N89-26492 20-63)
(Grants NIHR-G008300075; NSF DMC-83-51827)
Avail: NTIS HC A18/MF A01 CSCL 09B

An advanced method of tracking three-dimensional motion of bodies has been developed. This system has the potential to dynamically characterize machine and other structural motion, even in the presence of structural flexibility, thus facilitating closed loop structural motion control. The system's operation is based on the concept that the intersection of three planes defines a point. Three rotating planes of laser light, fixed and moving photovoltaic diode targets, and a pipe-lined architecture of analog and digital electronics are used to locate multiple targets whose number is only limited by available computer memory. Data collection rates are a function of the laser scan rotation speed and are currently selectable up to 480 Hz. The tested performance on a preliminary prototype designed for 0.1 in accuracy (for tracking human motion) at a 480 Hz data rate includes a worst case resolution of 0.8 mm (0.03 inches), a repeatability of plus or minus 0.635 mm (plus or minus 0.025 inches), and an absolute accuracy of plus or minus 2.0 mm (plus or minus 0.08 inches) within an eight cubic meter volume with all results applicable at the 95 percent level of confidence along each coordinate region. The full six degrees of freedom of a body can be computed by attaching three or more target detectors to the body of interest. Author

N89-26498*# Pennsylvania Univ., Philadelphia.
OBJECT APPREHENSION USING VISION AND TOUCH
R. Bajcsy and S. A. Stansfield *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 45-49 (For primary document see N89-26492 20-63)
(Contracts DAA6-29-84-K-0061; DAAB07-84-K-F077; AF-AFOSR-82-NM-299; NSF MCS-82-19196; NSF MCS-82-07294; NIH1-R01-HL-29985-01; N0014-85-K-0807)
Avail: NTIS HC A18/MF A01 CSCL 09B

Researchers define object apprehension as the determination of the properties of an object and the relationships among these properties. They contrast this with recognition, which goes a step further to attach a label to the object as a whole. Apprehension is fundamental to manipulation. This is true whether the manipulation is being carried out by an autonomous robot or is the result of teleoperation involving sensory feedback. Researchers present an apprehension paradigm using both vision and touch. In this model, they define a representation for object apprehension in terms of a set of primitives and features, along with their relationships. This representation is the mechanism by which the data from the two modalities are combined. It is also the mechanism which drives the apprehension process. Author

N89-26499*# Wisconsin Univ., Madison.
SENSORY SUBSTITUTION FOR SPACE GLOVES AND FOR SPACE ROBOTS
P. Bach-y-Rita, J. G. Webster, W. J. Tompkins, and T. Crabb (Astronautics Corp. of America, Madison, WI.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 51-57 (For primary document see N89-26492 20-63)
(Contract NAS6-9171; NAGw-975)
Avail: NTIS HC A18/MF A01 CSCL 09B

Sensory substitution systems for space applications are described. Physical sensors replace missing human receptors and feed information to the interpretive centers of a different sense. The brain is plastic enough so that, with training, the subject localizes the input as if it were received through the missing receptors. Astronauts have difficulty feeling objects through space suit gloves because of their thickness and because of the 4.3 psi pressure difference. Miniature force sensors on the glove palm drive an electrotactile belt around the waist, thus augmenting the missing tactile sensation. A proposed teleoperator system with telepresence for a space robot would incorporate teleproprioception and a force sensor/electrotactile belt sensory substitution system for teletouch. Author

N89-26500*# Cornell Univ., Ithaca, NY.
ELECTRONIC PROTOTYPING
J. Hopcroft *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 59-63 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

The potential benefits of automation in space are significant. The science base needed to support this automation not only will help control costs and reduce lead-time in the earth-based design and construction of space stations, but also will advance the nation's capability for computer design, simulation, testing, and debugging of sophisticated objects electronically. Progress in automation will require the ability to electronically represent, reason about, and manipulate objects. Discussed here is the development of representations, languages, editors, and model-driven simulation systems to support electronic prototyping. In particular, it identifies areas where basic research is needed before further progress can be made. Author

N89-26501*# Carnegie-Mellon Univ., Pittsburgh, PA.
MULTIPLE DEGREE OF FREEDOM OPTICAL PATTERN RECOGNITION
D. Casasent *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 65-70 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Three general optical approaches to multiple degree of freedom object pattern recognition (where no stable object rest position

exists) are advanced. These techniques include: feature extraction, correlation, and artificial intelligence. The details of the various processors are advanced together with initial results. Author

N89-26502*# Brown Univ., Providence, RI.
MAXIMUM LIKELIHOOD ESTIMATION OF PARAMETERIZED 3-D SURFACES USING A MOVING CAMERA
Y. Hung, B. Cernuschi-Frias, and D. B. Cooper *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 71-83 Sponsored in part by IBM Co., and Buenos Aires Univ. (For primary document see N89-26492 20-63)
(Contract DAAL-03-86-K-0011; NSF ECS-81-19676)
Avail: NTIS HC A18/MF A01 CSCL 09B

A new approach is introduced to estimating object surfaces in three-dimensional space from a sequence of images. A surface of interest here is modeled as a 3-D function known up to the values of a few parameters. The approach will work with any parameterization. However, in work to date researchers have modeled objects as patches of spheres, cylinders, and planes - primitive objects. These primitive surfaces are special cases of 3-D quadric surfaces. Primitive surface estimation is treated as the general problem of maximum likelihood parameter estimation based on two or more functionally related data sets. In the present case, these data sets constitute a sequence of images taken at different locations and orientations. A simple geometric explanation is given for the estimation algorithm. Though various techniques can be used to implement this nonlinear estimation, researches discuss the use of gradient descent. Experiments are run and discussed for the case of a sphere of unknown location. These experiments graphically illustrate the various advantages of using as many images as possible in the estimation and of distributing camera positions from first to last over as large a baseline as possible. Researchers introduce the use of asymptotic Bayesian approximations in order to summarize the useful information in a sequence of images, thereby drastically reducing both the storage and amount of processing required. Author

N89-26503*# Honeywell Systems and Research Center, Minneapolis, MN.
THE ARCHITECTURE OF A VIDEO IMAGE PROCESSOR FOR THE SPACE STATION **c60**
S. Yalamanchili, D. Lee, K. Fritze, T. Carpenter, K. Hoyme, and N. Murray (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 85-93 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

The architecture of a video image processor for space station applications is described. The architecture was derived from a study of the requirements of algorithms that are necessary to produce the desired functionality of many of these applications. Architectural options were selected based on a simulation of the execution of these algorithms on various architectural organizations. A great deal of emphasis was placed on the ability of the system to evolve and grow over the lifetime of the space station. The result is a hierarchical parallel architecture that is characterized by high level language programmability, modularity, extensibility and can meet the required performance goals. Author

N89-26504*# Perkin-Elmer Corp., Garden Grove, CA.
AN OPTICAL PROCESSOR FOR OBJECT RECOGNITION AND TRACKING **c74**
J. Sloan and S. Udomkesmalee *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 95-101 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 20F

The design and development of a miniaturized optical processor that performs real time image correlation are described. The optical correlator utilizes the Vander Lugt matched spatial filter technique. The correlation output, a focused beam of light, is imaged onto a CMOS photodetector array. In addition to performing target recognition, the device also tracks the target. The hardware, composed of optical and electro-optical components, occupies only 590 cu cm of volume. A complete correlator system would also include an input imaging lens. This optical processing system is compact, rugged, requires only 3.5 watts of operating power, and weighs less than 3 kg. It represents a major achievement in miniaturizing optical processors. When considered as a special-purpose processing unit, it is an attractive alternative to conventional digital image recognition processing. It is conceivable that the combined technology of both optical and dititial processing could result in a very advanced robot vision system. Author

N89-26505*# New York Univ., New York.
IMPROVED SHAPE-SIGNATURE AND MATCHING METHODS FOR MODEL-BASED ROBOTIC VISION
J. T. Schwartz and H. J. Wolfson *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 103-109 (For primary document see N89-26492 20-63)
(Contract N00014-82-K-0381; NSF DCR-83-20085)
Avail: NTIS HC A18/MF A01 CSCL 09B

Researchers describe new techniques for curve matching and model-based object recognition, which are based on the notion of shape-signature. The signature which researchers use is an approximation of pointwise curvature. Described here is curve matching algorithm which generalizes a previous algorithm which was developed using this signature, allowing improvement and generalization of a previous model-based object recognition scheme. The results and the experiments described relate to 2-D images. However, natural extensions to the 3-D case exist and are being developed. Author

N89-26506*# Rice Univ., Houston, TX.
A TECHNIQUE FOR 3-D ROBOT VISION FOR SPACE APPLICATIONS
V. Markandey, H. Tagare, and R. J. P. deFigueiredo *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 111-123 (For primary document see N89-26492 20-63)
(Contracts NAS9-17145; NCC9-16; NSF DCR-83-18514)
Avail: NTIS HC A18/MF A01 CSCL 09B

An extension of the MIAG algorithm for recognition and motion parameter determination of general 3-D polyhedral objects based on model matching techniques and using Moment Invariants as features of object representation is discussed. Results of tests conducted on the algorithm under conditions simulating space conditions are presented. Author

N89-26507*# Ohio State Univ., Columbus.
DIFFERENTIAL SURFACE MODELS FOR TACTILE PERCEPTION OF SHAPE AND ON-LINE TRACKING OF FEATURES
H. Hemami *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 125-130 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Tactile perception of shape involves an on-line controller and a shape perceptor. The purpose of the on-line controller is to maintain gliding or rolling contact with the surface, and collect information, or track specific features of the surface such as edges of a certain sharpness. The shape perceptor uses the information to perceive, estimate the parameters of, or recognize the shape. The differential surface model depends on the information collected and on the a priori information known about the robot and its physical parameters. These differential models are certain functionals that are projections of the dynamics of the robot onto the surface gradient or onto the tangent plane. A number of differential properties may be directly measured from present day tactile sensors. Others may have to be indirectly computed from measurements. Others may constitute design objectives for distributed tactile sensors of the future. A parameterization of the

surface leads to linear and nonlinear sequential parameter estimation techniques for identification of the surface. Many interesting compromises between measurement and computation are possible.
Author

N89-26508*# FMC Corp., Santa Clara, CA.
CONSTRAINT-BASED STEREO MATCHING
D. T. Kuan *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 131-134 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

The major difficulty in stereo vision is the correspondence problem that requires matching features in two stereo images. Researchers describe a constraint-based stereo matching technique using local geometric constraints among edge segments to limit the search space and to resolve matching ambiguity. Edge segments are used as image features for stereo matching. Epipolar constraint and individual edge properties are used to determine possible initial matches between edge segments in a stereo image pair. Local edge geometric attributes such as continuity, junction structure, and edge neighborhood relations are used as constraints to guide the stereo matching process. The result is a locally consistent set of edge segment correspondences between stereo images. These locally consistent matches are used to generate higher-level hypotheses on extended edge segments and junctions to form more global contexts to achieve global consistency.
Author

N89-26509*# New Mexico State Univ., Las Cruces.
A DATABASE/KNOWLEDGE STRUCTURE FOR A ROBOTICS VISION SYSTEM
D. W. Dearholt and N. N. Gonzales *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 135-143 (For primary document see N89-26492 20-63)
(Grant NSF IST-85-06706)
Avail: NTIS HC A18/MF A01 CSCL 09B

Desirable properties of robotics vision database systems are given, and structures which possess properties appropriate for some aspects of such database systems are examined. Included in the structures discussed is a family of networks in which link membership is determined by measures of proximity between pairs of the entities stored in the database. This type of network is shown to have properties which guarantee that the search for a matching feature vector is monotonic. That is, the database can be searched with no backtracking, if there is a feature vector in the database which matches the feature vector of the external entity which is to be identified. The construction of the database is discussed, and the search procedure is presented. A section on the support provided by the database for description of the decision-making processes and the search path is also included.
Author

N89-26510*# California Univ., Los Angeles.
SENSING AND PERCEPTION: CONNECTIONIST APPROACHES TO SUBCOGNITIVE COMPUTING
J. Skrrypek *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 145-153 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

New approaches to machine sensing and perception are presented. The motivation for crossdisciplinary studies of perception in terms of AI and neurosciences is suggested. The question of computing architecture granularity as related to global/local computation underlying perceptual function is considered and examples of two environments are given. Finally, the examples of using one of the environments, UCLA PUNNS, to study neural architectures for visual function are presented.
Author

N89-26511*# California Univ., Davis.
PARALLEL PROCESSING FOR DIGITAL PICTURE COMPARISON **c62**
H. D. Cheng and L. T. Kou *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 155-161 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

In picture processing an important problem is to identify two digital pictures of the same scene taken under different lighting conditions. This kind of problem can be found in remote sensing, satellite signal processing and the related areas. The identification can be done by transforming the gray levels so that the gray level histograms of the two pictures are closely matched. The transformation problem can be solved by using the packing method. Researchers propose a VLSI architecture consisting of m x n processing elements with extensive parallel and pipelining computation capabilities to speed up the transformation with the time complexity 0(max(m,n)), where m and n are the numbers of the gray levels of the input picture and the reference picture respectively. If using uniprocessor and a dynamic programming algorithm, the time complexity will be 0(m(3)xn). The algorithm partition problem, as an important issue in VLSI design, is discussed. Verification of the proposed architecture is also given.
Author

N89-26512*# Brown Univ., Providence, RI.
INVERSE KINEMATIC-BASED ROBOT CONTROL
W. A. Wolovich and K. F. Flueckiger *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 165-175 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

A fundamental problem which must be resolved in virtually all non-trivial robotic operations is the well-known inverse kinematic question. More specifically, most of the tasks which robots are called upon to perform are specified in Cartesian (x,y,z) space, such as simple tracking along one or more straight line paths or following a specified surfacer with compliant force sensors and/or visual feedback. In all cases, control is actually implemented through coordinated motion of the various links which comprise the manipulator; i.e., in link space. As a consequence, the control computer of every sophisticated anthropomorphic robot must contain provisions for solving the inverse kinematic problem which, in the case of simple, non-redundant position control, involves the determination of the first three link angles, theta sub 1, theta sub 2, and theta sub 3, which produce a desired wrist origin position P sub xw, P sub yw, and P sub zw at the end of link 3 relative to some fixed base frame. Researchers outline a new inverse kinematic solution and demonstrate its potential via some recent computer simulations. They also compare it to current inverse kinematic methods and outline some of the remaining problems which will be addressed in order to render it fully operational. Also discussed are a number of practical consequences of this technique beyond its obvious use in solving the inverse kinematic question.
Author

N89-26513*# California Inst. of Tech., Pasadena.
SPATIALLY RANDOM MODELS, ESTIMATION THEORY, AND ROBOT ARM DYNAMICS **c37**
G. Rodriguez *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 177-184 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

Spatially random models provide an alternative to the more traditional deterministic models used to describe robot arm dynamics. These alternative models can be used to establish a relationship between the methodologies of estimation theory and robot dynamics. A new class of algorithms for many of the fundamental robotics problems of inverse and forward dynamics, inverse kinematics, etc. can be developed that use computations typical in estimation theory. The algorithms make extensive use

of the difference equations of Kalman filtering and Bryson-Frazier smoothing to conduct spatial recursions. The spatially random models are very easy to describe and are based on the assumption that all of the inertial (D'Alembert) forces in the system are represented by a spatially distributed white-noise model. The models can also be used to generate numerically the composite multibody system inertia matrix. This is done without resorting to the more common methods of deterministic modeling involving Lagrangian dynamics, Newton-Euler equations, etc. These methods make substantial use of human knowledge in derivation and minipulation of equations of motion for complex mechanical systems. Author

N89-26514*# Integrated Systems, Inc., Palo Alto, CA.
TASK ORIENTED NONLINEAR CONTROL LAWS FOR TELEROBOTIC ASSEMBLY OPERATIONS **c37**
R. A. Walker, L. S. Ward, and C. F. Elia *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 185-195 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

The goal of this research is to achieve very intelligent telerobotic controllers which are capable of receiving high-level commands from the human operator and implementing them in an adaptive manner in the object/task/manipulator workspace. Initiatives by the authors at Integrated Systems, Inc. to identify and develop the key technologies necessary to create such a flexible, highly programmable, telerobotic controller are presented. The focus of the discussion is on the modeling of insertion tasks in three dimensions and nonlinear implicit force feedback control laws which incorporate tool/workspace constraints. Preliminary experiments with dual arm beam assembly in 2-D are presented. Author

N89-26515*# Hewlett-Packard Co., Cupertino, CA.
A UNIVERSAL SIX-JOINT ROBOT CONTROLLER **c37**
D. G. Bihn and T. C. Hsia (California Univ., Davis.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 197-206 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

A general purpose six-axis robotic manipulator controller was designed and implemented to serve as a research tool for the investigation of the practical and theoretical aspects of various control strategies in robotics. A 80286-based Intel System 310 running the Xenix operating servo software as well as the higher level software (e.g., kinematics and path planning) were employed. A Multibus compatible interface board was designed and constructed to handle I/O signals from the robot manipulator's joint motors. From the design point of view, the universal controller is capable of driving robot manipulators equipped with D.C. joint motors and position optical encoders. To test its functionality, the controller is connected to the joint motor D.C. power amplifier of a PUMA 560 arm bypassing completely the manufacturer-supplied Unimation controller. A controller algorithm consisting of local PD control laws was written and installed into the Xenix operating system. Additional software drivers were implemented to allow application programs access to the interface board. All software was written in the C language. Author

N89-26516*# McDonnell-Douglas Aerospace Information Services Co., Saint Louis, MO.
REAL-TIME GRAPHIC SIMULATION FOR SPACE TELEROBOTICS APPLICATIONS **c61**
E. W. Baumann *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 207-217 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Designing space-based telerobotic systems presents many problems unique to telerobotics and the space environment, but it also shares many common hardware and software design problems with Earth-based industrial robot applications. Such problems include manipulator design and placement, grapple-fixture design, and of course the development of effective and reliable control algorithms. Since first being applied to industrial robotics just a few years ago, interactive graphic simulation has proven to be a powerful tool for anticipating and solving problems in the design of Earth-based robotic systems and processes. Where similar problems are encountered in the design of space-based robotic mechanisms, the same graphic simulation tools may also be of assistance. The capabilities of PLACE, a commercially available interactive graphic system for the design and simulation of robotic systems and processes is described. A space-telerobotics application of the system is presented and discussed. Potential future enhancements are described. Author

N89-26517*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MANIPULATOR CONTROL AND MECHANIZATION: A TELEROBOT SUBSYSTEM **c37**
S. Hayati and B. Wilcox *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 219-227 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

The short- and long-term autonomous robot control activities in the Robotics and Teleoperators Research Group at the Jet Propulsion Laboratory (JPL) are described. This group is one of several involved in robotics and is an integral part of a new NASA robotics initiative called Telerobot program. A description of the architecture, hardware and software, and the research direction in manipulator control is given. Author

N89-26518*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
CHAOS MOTION IN ROBOT MANIPULATORS **c37**
A. Lokshin and M. Zak *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 229-234 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

It is shown that a simple two-link planar manipulator exhibits a phenomenon of global instability in a subspace of its configuration space. A numerical example, as well as results of a graphic simulation, is given. Author

N89-26519*# Carnegie-Mellon Univ., Pittsburgh, PA.
EFFECT OF CONTROL SAMPLING RATES ON MODEL-BASED MANIPULATOR CONTROL SCHEMES **c37**
P. K. Khosla *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 235-243 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

The effect of changing the control sampling period on the performance of the computed-torque and independent joint control schemes is discussed. While the former utilizes the complete dynamics model of the manipulator, the latter assumes a decoupled and linear model of the manipulator dynamics. Researchers discuss the design of controller gains for both the computed-torque and the independent joint control schemes and establish a framework for comparing their trajectory tracking performance. Experiments show that within each scheme the trajectory tracking accuracy varies slightly with the change of the sampling rate. However, at low sampling rates the computed-torque scheme outperforms the independent joint control scheme. Based on experimental results, researchers also conclusively establish the importance of high sampling rates as they result in an increased stiffness of the system. Author

N89-26520*# Scientific Systems, Inc., Cambridge, MA.
KINEMATICALLY REDUNDANT ROBOT MANIPULATORS **c37**
J. Baillieul, J. Hollerbach, R. Brockett (Harvard Univ., Cambridge, MA.), D. Martin, R. Percy, and R. Thomas *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 245-255 Prepared in cooperation with Boston Univ., MA (For primary document

see N89-26492 20-63)
(Contract F33615-84-C-5131)
Avail: NTIS HC A18/MF A01 CSCL 13I

Research on control, design and programming of kinematically redundant robot manipulators (KRRM) is discussed. These are devices in which there are more joint space degrees of freedom than are required to achieve every position and orientation of the end-effector necessary for a given task in a given workspace. The technological developments described here deal with: kinematic programming techniques for automatically generating joint-space trajectories to execute prescribed tasks; control of redundant manipulators to optimize dynamic criteria (e.g., applications of forces and moments at the end-effector that optimally distribute the loading of actuators); and design of KRRMs to optimize functionality in congested work environments or to achieve other goals unattainable with non-redundant manipulators. Kinematic programming techniques are discussed, which show that some pseudo-inverse techniques that have been proposed for redundant manipulator control fail to achieve the goals of avoiding kinematic singularities and also generating closed joint-space paths corresponding to close paths of the end effector in the workspace. The extended Jacobian is proposed as an alternative to pseudo-inverse techniques. Author

N89-26521*# California Univ., Los Angeles.
CONTROL STRATEGY FOR A DUAL-ARM MANEUVERABLE SPACE ROBOT **c37**
P. K. C. Wang *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 257-266 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

A simple strategy for the attitude control and arm coordination of a maneuverable space robot with dual arms is proposed. The basic task for the robot consists of the placement of marked rigid solid objects with specified pairs of gripping points and a specified direction of approach for gripping. The strategy consists of three phases each of which involves only elementary rotational and translational collision-free maneuvers of the robot body. Control laws for these elementary maneuvers are derived by using a body-referenced dynamic model of the dual-arm robot. Author

N89-26522*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A SPACE SYSTEMS PERSPECTIVE OF GRAPHICS SIMULATION INTEGRATION **c61**
R. Brown, C. Gott, G. Sabionski, and D. Bochsler (LinCom Corp., Houston, TX.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 267-272 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Creation of an interactive display environment can expose issues in system design and operation not apparent from nongraphics development approaches. Large amounts of information can be presented in a short period of time. Processes can be simulated and observed before committing resources. In addition, changes in the economics of computing have enabled broader graphics usage beyond traditional engineering and design into integrated telerobotics and Artificial Intelligence (AI) applications. The highly integrated nature of space operations often tend to rely upon visually intensive man-machine communication to ensure success. Graphics simulation activities at the Mission Planning and Analysis Division (MPAD) of NASA's Johnson Space Center are focusing on the evaluation of a wide variety of graphical analysis within the context of present and future space operations. Several telerobotics and AI applications studies utilizing graphical simulation are described. The presentation includes portions of videotape illustrating technology developments involving: (1) coordinated manned maneuvering unit and remote manipulator system operations, (2) a helmet mounted display system, and (3) an automated rendezous application utilizing expert system and voice input/output technology. Author

N89-26523*# New Hampshire Univ., Durham.
A LEARNING CONTROLLER FOR NONREPETITIVE ROBOTIC OPERATION
W. T. Miller, III *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 273-281 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

A practical learning control system is described which is applicable to complex robotic and telerobotic systems involving multiple feedback sensors and multiple command variables. In the controller, the learning algorithm is used to learn to reproduce the nonlinear relationship between the sensor outputs and the system command variables over particular regions of the system state space, rather than learning the actuator commands required to perform a specific task. The learned information is used to predict the command signals required to produce desired changes in the sensor outputs. The desired sensor output changes may result from automatic trajectory planning or may be derived from interactive input from a human operator. The learning controller requires no a priori knowledge of the relationships between the sensor outputs and the command variables. The algorithm is well suited for real time implementation, requiring only fixed point addition and logical operations. The results of learning experiments using a General Electric P-5 manipulator interfaced to a VAX-11/730 computer are presented. These experiments involved interactive operator control, via joysticks, of the position and orientation of an object in the field of view of a video camera mounted on the end of the robot arm. Author

N89-26524*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FLEXIBLE TELEROBOTIC SYSTEM FOR SPACE OPERATIONS **c37**
N. O. Sliwa and R. W. Will *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 285-292 Previously announced in IAA as A87-23229 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

The objective and design of a proposed goal-oriented knowledge-based telerobotic system for space operations is described. This design effort encompasses the elements of the system executive and user interface and the distribution and general structure of the knowledge base, the displays, and the task sequencing. The objective of the design effort is to provide an expandable structure for a telerobotic system that provides cooperative interaction between the human operator and computer control. The initial phase of the implementation provides a rule-based, goal-oriented script generator to interface to the existing control modes of a telerobotic research system, in the Intelligent Systems Research Lab at NASA Research Center. Author

N89-26525*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SYSTEMS SIMULATIONS SUPPORTING NASA TELEROBOTICS **c61**
F. W. Harrison, Jr. and J. E. Pennington *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 293-299 Previously announced in IAA as A87-23227 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Two simulation and analysis environments have been developed to support telerobotics research at the Langley Research Center. One is a high-fidelity, nonreal-time, interactive model called ROBSIM, which combines user-generated models of workspace environment, robots, and loads into a working system and simulates the interaction among the system components. Models include user-specified actuator, sensor, and control parameters, as well as kinematic and dynamic characteristics. Kinematic, dynamic, and response analyses can be selected, with system configuration, task trajectories, and arm states displayed using computer graphics.

The second environment is a real-time, manned Telerobotic Systems Simulation (TRSS) which uses the facilities of the Intelligent Systems Research Laboratory (ISRL). It utilizes a hierarchical structure of functionally distributed computers communicating over both parallel and high-speed serial data paths to enable studies of advanced telerobotic systems. Multiple processes perform motion planning, operator communications, forward and inverse kinematics, control/sensor fusion, and I/O processing while communicating via common memory. Both ROBSIM and TRSS, including their capability, status, and future plans are discussed. Also described is the architecture of ISRL and recent telerobotic system studies in ISRL. Author

N89-26526*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COORDINATION OF MULTIPLE ROBOT ARMS **c37**
L. K. Barker and D. Soloway *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 301-305 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

Kinematic resolved-rate control from one robot arm is extended to the coordinated control of multiple robot arms in the movement of an object. The structure supports the general movement of one axis system (moving reference frame) with respect to another axis system (control reference frame) by one or more robot arms. The grippers of the robot arms do not have to be parallel or at any pre-disposed positions on the object. For multiarm control, the operator chooses the same moving and control reference frames for each of the robot arms. Consequently, each arm then moves as though it were carrying out the commanded motions by itself. Author

N89-26527*# American Welding Inst., Louisville, TN.
DEVELOPMENT OF A SEMI-AUTONOMOUS SERVICE ROBOT WITH TELEROBOTIC CAPABILITIES **c37**
J. E. Jones and D. R. White (MTS Systems Corp., Minneapolis, MN.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 307-316 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

The importance to the United States of semi-autonomous systems for application to a large number of manufacturing and service processes is very clear. Two principal reasons emerge as the primary driving forces for development of such systems: enhanced national productivity and operation in environments whch are hazardous to humans. Completely autonomous systems may not currently be economically feasible. However, autonomous systems that operate in a limited operation domain or that are supervised by humans are within the technology capability of this decade and will likely provide reasonable return on investment. The two research and development efforts of autonomy and telerobotics are distinctly different, yet interconnected. The first addresses the communication of an intelligent electronic system with a robot while the second requires human communication and ergonomic consideration. Discussed here are work in robotic control, human/robot team implementation, expert system robot operation, and sensor development by the American Welding Institute, MTS Systems Corporation, and the Colorado School of Mines--Center for Welding Research. Author

N89-26528*# Martin Marietta Aerospace, Denver, CO.
A TASK-BASED METRIC FOR TELEROBOTIC PERFORMANCE ASSESSMENT **c37**
J. F. Barnes *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 317-324 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

A methodology is described for developing a task complexity index based on combining the six basic motion primitives (three translation, three orientation) with force control and accuracy requirements. The result of this development is a set of complexity values that can be assigned to the high-level task primitives derived from a relatively shallow top-down mission analysis. These values are then averaged to arrive at total average mission complexities, such as for the mission of exchanging the Hubble Space Telescope (HST) battery modules. Application of this metric to a candidate set of NASA Flight Telerobotic Servicer evaluation tasks is discussed using the HST battery module mission for an in-depth example. Author

N89-26529*# Clemson Univ., SC.
MOTION COORDINATION AND PROGRAMMABLE TELEOPERATION BETWEEN TWO INDUSTRIAL ROBOTS **c37**
J. Y. S. Luh and Y. F. Zheng *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 325-334 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

Tasks for two coordinated industrial robots always bring the robots in contact with a same object. The motion coordination among the robots and the object must be maintained all the time. To plan the coordinated tasks, only one robot's motion is planned according to the required motion of the object. The motion of the second robot is to follow the first one as specified by a set of holonomic equality constraints at every time instant. If any modification of the object's motion is needed in real-time, only the first robot's motion has to be modified accordingly in real-time. The modification for the second robot is done implicitly through the constraint conditions. Thus the operation is simplified. If the object is physically removed, the second robot still continually follows the first one through the constraint conditions. If the first robot is maneuvered through either the teach pendant or the keyboard, the second one moves accordingly to form the teleoperation which is linked through the software programming. Obviously, the second robot does not need to duplicate the first robot's motion. The programming of the constraints specifies their relative motions. Author

N89-26530*# ORINTEC, Vallejo, CA.
USE OF CONTROL UMBILICALS AS A DEPLOYMENT MODE FOR FREE FLYING TELEROBOTIC WORK SYSTEMS **c37**
J. S. Kuehn and E. D. Selle *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 335-339 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

Work to date on telerobotic work systems for use in space generally consider two deployment modes, free flying, or fixed within a limited work envelope. Control tethers may be employed to obtain a number of operational advantages and added flexibility in the basing and deployment of telerobotic work systems. Use of a tether allows the work system to be separated into two major modules, the remote work package and the control module. The Remote Work Package (RWP) comprises the free flying portion of the work system while the Control Module (CM) remains at the work system base. The chief advantage of this configuration is that only the components required for completion of the work task must be located at the work site. Reaction mass used in free flight is stored at the Control module and supplied to the RWP through the tether, eliminating the need for the RWP to carry it. The RWP can be made less massive than a self contained free flying work system. As a result, reaction mass required for free flight is lower than for a self contained free flyer. Author

N89-26531*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
THE DESIGN OF A NINE-STRING SIX-DEGREE-OF-FREEDOM FORCE-FEEDBACK JOYSTICK FOR TELEMANIPULATION **c37**
M. L. Agronin *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 341-348 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

An overview is given of the design and controlling equations for a 6-degree-of-freedom force-feedback joystick for teleman-ipulation. The joystick has a parallel mechanical structure which allows all of its actuators to be fixed to a non-moving base. The low-inertia design is expected to provide an accurate force-feedback signal to the joystick operator without the need for closed-loop momentum compensation. The analysis describes the joystick's inputs and outputs in generalized Cartesian space, so the joystick can potentially be used as an interface for any 6-degree-of-freedom device. Author

N89-26532*# Massachusetts Inst. of Tech., Cambridge.
ISSUES IN HUMAN/COMPUTER CONTROL OF DEXTEROUS REMOTE HANDS **c54**
K. Salisbury *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 351-360 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 05H

Much research on dexterous robot hands has been aimed at the design and control problems associated with their autonomous operation, while relatively little research has addressed the problem of direct human control. It is likely that these two modes can be combined in a complementary manner yielding more capability than either alone could provide. While many of the issues in mixed computer/human control of dexterous hands parallel those found in supervisory control of traditional remote manipulators, the unique geometry and capabilities of dexterous hands pose many new problems. Among these are the control of redundant degrees of freedom, grasp stabilization and specification of non-anthropomorphic behavior. An overview is given of progress made at the MIT AI Laboratory in control of the Salisbury 3 finger hand, including experiments in grasp planning and manipulation via controlled slip. It is also suggested how we might introduce human control into the process at a variety of functional levels. Author

N89-26533*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MAN-MACHINE INTERFACE ISSUES IN SPACE TELEROBOTICS: A JPL RESEARCH AND DEVELOPMENT PROGRAM **c54**
A. K. Bejczy *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 361-369 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 05H

Technology issues related to the use of robots as man-extension or telerobot systems in space are discussed and exemplified. General considerations are presentd on control and information problems in space teleoperation and on the characteristics of Earth orbital teleoperation. The JPL R and D work in the area of man-machine interface devices and techniques for sensing and computer-based control is briefly summarized. The thrust of this R and D effort is to render space teleoperation efficient and safe through the use of devices and techniques which will permit integrated and task-level (intelligent) two-way control com-munication between human operator and telerobot machine in Earth orbit. Specific control and information display devices and techniques are discussed and exemplified with development results obtained at JPL in recent years. Author

N89-26534*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
TASK-LEVEL TESTING OF THE JPL-OMV SMART END EFFECTOR **c37**
B. Hannaford *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 371-379 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

An intelligent end effector previously developed at JPL has been tested in over 21 hours of experimental teleoperation. The end effector provides local control of gripper clamping force and a 6-degree-of-freedom, wrist mounted force torque sensor. Resolved forces and torques were displayed to the test subjects, and the effect of this information on their performance of simulated satellite servicing tasks was assessed. The experienced subjects accomplished the tasks with lower levels of Remote Manipulator System (RMS) forces than intermediate and naive subjects, but the force levels were apparently uncorrelated with the presence or absence of the display. This negative finding was attributed to the lack of a suitable control mode in the manipulator control system. Author

N89-26535*# Veterans Administration Hospital, Palo Alto, CA.
A NATURAL-LANGUAGE INTERFACE TO A MOBILE ROBOT **c61**
S. Michalowski, C. Crangle, and L. Liang (Stanford Univ., CA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 381-391 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

The present work on robot instructability is based on an ongoing effort to apply modern manipulation technology to serve the needs of the handicapped. The Stanford/VA Robotic Aid is a mobile manipulation system that is being developed to assist severely disabled persons (quadriplegics) in performing simple activities of everyday living in a homelike, unstructured environment. It consists of two major components: a nine degree-of-freedom manipulator and a stationary control console. In the work presented here, only the motions of the Robotic Aid's omnidirectional motion base have been considered, i.e., the six degrees of freedom of the arm and gripper have been ignored. The goal has been to develop some basic software tools for commanding the robot's motions in an enclosed room containing a few objects such as tables, chairs, and rugs. In the present work, the environmental model takes the form of a two-dimensional map with objects represented by polygons. Admittedly, such a highly simplified scheme bears little resemblance to the elaborate cognitive models of reality that are used in normal human discourse. In particular, the polygonal model is given a priori and does not contain any perceptual elements: there is no polygon sensor on board the mobile robot. Author

N89-26536*# Stanford Univ., CA.
TYPES OF VERBAL INTERACTION WITH INSTRUCTABLE ROBOTS **c61**
C. Crangle, P. Suppes, and S. Michalowski (Veterans Administration Hospital, Palo Alto, CA.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 393-402 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

An instructable robot is one that accepts instruction in some natural language such as English and uses that instruction to extend its basic repertoire of actions. Such robots are quite different in conception from autonomously intelligent robots, which provide the impetus for much of the research on inference and planning in artificial intelligence. Examined here are the significant problem areas in the design of robots that learn from vebal instruction. Examples are drawn primarily from our earlier work on instructable robots and recent work on the Robotic Aid for the physically disabled. Natural-language understanding by machines is discussed as well as in the possibilities and limits of verbal instruction. The core problem of verbal instruction, namely, how to achieve specific concrete action in the robot in response to commands that express general intentions, is considered, as are two major challenges to instructability: achieving appropriate real-time behavior in the robot, and extending the robot's language capabilities. Author

N89-26537*# Massachusetts Inst. of Tech., Cambridge.
MIT RESEARCH IN TELEROBOTICS **c37**
T. B. Sheridan *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 403-412 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

Ongoing MIT research in telerobotics (vehicles capable of

some autonomous sensing and manipulating, having some remote supervisory control by people) and teleoperation (vehicles for sensing and manipulating which are fully controlled remotely by people) is discussed. The current efforts mix human and artificial intelligence/control. The idea of adjustable impedance at either end of pure master-slave teleoperation, and simultaneous coordinated control of teleoperator/telerobotic systems which have more than six degrees of freedom (e.g., a combined vehicle and arm, each with five or six DOF) are discussed. A new cable-controlled parallel link arm which offers many advantages over conventional arms for space is briefly described. Predictor displays to compensate for time delay in teleoperator loops, the use of state estimation to help human control decisions in space, and ongoing research in supervisory command language are covered. Finally, efforts to build a human flyable real-time dynamic computer-graphic telerobot simulator are described. These projects represent most, but not all, of the telerobotics research in our laboratory, supported by JPL, NASA Ames and NOAA. Author

N89-26538*# California Univ., Berkeley.
TELEROBOTICS: A SIMULATION FACILITY FOR UNIVERSITY RESEARCH **c61**
L. Stark, W. Kim, F. Tendick, M. Tyler, B. Hannaford, W. Barakat, O. Bergengruen, L. Braddi, J. Eisenberg, and S. Ellis et al *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 413-421 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

An experimental telerobotics (TR) simulation suitable for studying human operator (H.O.) performance is described. Simple manipulator pick-and-place and tracking tasks allowed quantitative comparison of a number of calligraphic display viewing conditions. A number of control modes could be compared in this TR simulation, including displacement, rate and acceleratory control using position and force joysticks. A homeomorphic controller turned out to be no better than joysticks; the adaptive properties of the H.O. can apparently permit quite good control over a variety of controller configurations and control modes. Training by optimal control example seemed helpful in preliminary experiments. An introduced communication delay was found to produce decrease in performance. In considerable part, this difficulty could be compensated for by preview control information. That neurological control of normal human movement contains a data period of 0.2 second may relate to this robustness of H.O. control to delay. The Ames-Berkeley enhanced perspective display was utilized in conjunction with an experimental helmet mounted display system (HMD) that provided stereoscopic enhanced views. Author

N89-26539*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MIXED-INITIATIVE CONTROL OF INTELLIGENT SYSTEMS **c61**
G. C. Borchardt *In its* Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 423-432 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Mixed-initiative user interfaces provide a means by which a human operator and an intelligent system may collectively share the task of deciding what to do next. Such interfaces are important to the effective utilization of real-time expert systems as assistants in the execution of critical tasks. Presented here is the Incremental Inference algorithm, a symbolic reasoning mechanism based on propositional logic and suited to the construction of mixed-initiative interfaces. The algorithm is similar in some respects to the Truth Maintenance System, but replaces the notion of 'justifications' with a notion of recency, allowing newer values to override older values yet permitting various interested parties to refresh these values as they become older and thus more vulnerable to change. A simple example is given of the use of the Incremental Inference algorithm plus an overview of the integration of this mechanism within the SPECTRUM expert system for geological interpretation of imaging spectrometer data. Author

N89-26540*# Stanford Univ., CA.
REPORT ON THE STANFORD/AMES DIRECT-LINK SPACE SUIT PREHENSOR **c54**
J. W. Jameson and Larry Leifer *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 433-442 Sponsored by NASA. Ames Research Center (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 05H

Researchers at the Center for Design Research at Stanford University, in collaboration with NASA Ames at Moffet Field, California, are developing hand-powered mechanical prehensors to replace gloves for EVA spacesuits. The design and functional properties of the first version Direct Link Prehensor (DLP) is discussed. It has a total of six degrees-of-freedom and is the most elaborate of three prehensors being developed for the project. The DLP has a robust design and utilizes only linkages and revolute joints for the drive system. With its anthropomorphic configuration of two fingers and a thumb, it is easy to control and is capable of all of the basic prehension patterns such as cylindrical or lateral pinch grasps. Kinematic analysis reveals that, assuming point contacts, a grasped object can be manipulated with three degrees-of-freedom. Yet, in practice more degrees-of-freedom are possible. Author

N89-26541*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PROCEEDINGS OF THE WORKSHOP ON SPACE TELEROBOTICS, VOLUME 3
G. Rodriguez, ed. 1 Jul. 1987 412 p Workshop held in Pasadena, CA, 20-22 Jan. 1987; sponsored by NASA, Washington, DC
(NASA-CR-184687; JPL-Publ-87-13-Vol-3; NAS 1.26:184687)
Avail: NTIS HC A18/MF A01 CSCL 09B

Planning and scheduling for robot applications, trajectory planning for manipulators, and manipulator control are discussed. For individual titles, see N89-26542 through N89-26577.

N89-26542*# McDonnell-Douglas Research Labs., Saint Louis, MO.
THE MECHANISMS OF TEMPORAL INFERENCE **c61**
B. R. Fox and S. R. Green (McDonnell-Douglas Astronautics Co., Cocoa Beach, FL.) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 9-15 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

The properties of a temporal language are determined by its constituent elements: the temporal objects which it can represent, the attributes of those objects, the relationships between them, the axioms which define the default relationships, and the rules which define the statements that can be formulated. The methods of inference which can be applied to a temporal language are derived in part from a small number of axioms which define the meaning of equality and order and how those relationships can be propagated. More complex inferences involve detailed analysis of the stated relationships. Perhaps the most challenging area of temporal inference is reasoning over disjunctive temporal constraints. Simple forms of disjunction do not sufficiently increase the expressive power of a language while unrestricted use of disjunction makes the analysis NP-hard. In many cases a set of disjunctive constraints can be converted to disjunctive normal form and familiar methods of inference can be applied to the conjunctive sub-expressions. This process itself is NP-hard but it is made more tractable by careful expansion of a tree-structured search space. Author

N89-26543*# Edinburgh Univ. (Scotland).
CONTINGENT PLAN STRUCTURES FOR SPACECRAFT **c18**
M. Drummond, K. Currie, and A. Tate *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 17-25 (For primary document see N89-26541 20-63)

(Grants GR/D/58987; GR/E/05421)
Avail: NTIS HC A18/MF A01 CSCL 22B

Most current AI planners build partially ordered plan structures which delay decisions on action ordering. Such structures cannot easily represent contingent actions. A representation which can is presented. The representation has some other useful features: it provides a good account of the causal structure of a plan, can be used to describe disjunctive actions, and it offers a planner the opportunity of even less commitment than the classical partial order on actions. The use of this representation is demonstrated in an on-board spacecraft activity sequencing problem. Contingent plan execution in a spacecraft context highlights the requirements for a fully disjunctive representation, since communication delays often prohibit extensive ground-based accounting for remotely sensed information and replanning on execution failure. Author

N89-26544*# Stanford Research Inst., Menlo Park, CA.
REASONING AND PLANNING IN DYNAMIC DOMAINS: AN EXPERIMENT WITH A MOBILE ROBOT
M. P. Georgeff, A. L. Lansky, and M. J. Schoppers *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 27-39 (For primary document see N89-26541 20-63)
(Contracts N00014-85-C-0251; FMC-147466)
Avail: NTIS HC A18/MF A01 CSCL 09B

Progress made toward having an autonomous mobile robot reason and plan complex tasks in real-world environments is described. To cope with the dynamic and uncertain nature of the world, researchers use a highly reactive system to which is attributed attitudes of belief, desire, and intention. Because these attitudes are explicitly represented, they can be manipulated and reasoned about, resulting in complex goal-directed and reflective behaviors. Unlike most planning systems, the plans or intentions formed by the system need only be partly elaborated before it decides to act. This allows the system to avoid overly strong expectations about the environment, overly constrained plans of action, and other forms of over-commitment common to previous planners. In addition, the system is continuously reactive and has the ability to change its goals and intentions as situations warrant. Thus, while the system architecture allows for reasoning about means and ends in much the same way as traditional planners, it also posseses the reactivity required for survival in complex real-world domains. The system was tested using SRI's autonomous robot (Flakey) in a scenario involving navigation and the performance of an emergency task in a space station scenario. Author

N89-26545*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
ROUTE PLANNING IN A FOUR-DIMENSIONAL ENVIRONMENT
M. G. Slack and D. P. Miller *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 41-47 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Robots must be able to function in the real world. The real world involves processes and agents that move independently of the actions of the robot, sometimes in an unpredictable manner. A real-time integrated route planning and spatial representation system for planning routes through dynamic domains is presented. The system will find the safest most efficient route through space-time as described by a set of user defined evaluation functions. Because the route planning algorthims is highly parallel and can run on an SIMD machine in O(p) time (p is the length of a path), the system will find real-time paths through unpredictable domains when used in an incremental mode. Spatial representation, an SIMD algorithm for route planning in a dynamic domain, and results from an implementation on a traditional computer architecture are discussed. Author

N89-26546*# Brown Univ., Providence, RI.
PREDICTION AND CAUSAL REASONING IN PLANNING
T. Dean and M. Boddy *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 49-58 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Nonlinear planners are often touted as having an efficiency advantage over linear planners. The reason usually given is that nonlinear planners, unlike their linear counterparts, are not forced to make arbitrary commitments to the order in which actions are to be performed. This ability to delay commitment enables nonlinear planners to solve certain problems with far less effort than would be required of linear planners. Here, it is argued that this advantage is bought with a significant reduction in the ability of a nonlinear planner to accurately predict the consequences of actions. Unfortunately, the general problem of predicting the consequences of a partially ordered set of actions is intractable. In gaining the predictive power of linear planners, nonlinear planners sacrifice their efficiency advantage. There are, however, other advantages to nonlinear planning (e.g., the ability to reason about partial orders and incomplete information) that make it well worth the effort needed to extend nonlinear methods. A framework is supplied for causal inference that supports reasoning about partially ordered events and actions whose effects depend upon the context in which they are executed. As an alternative to a complete but potentially exponential-time algorithm, researchers provide a provably sound polynomial-time algorithm for predicting the consequences of partially ordered events. Author

N89-26547*# Ohio State Univ., Columbus.
THE GENERIC TASK TOOLSET: HIGH LEVEL LANGUAGES FOR THE CONSTRUCTION OF PLANNING AND PROBLEM SOLVING SYSTEMS
B. Chandrasekaran, J. Josephson, and D. Herman *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 59-66 (For primary document see N89-26541 20-63)
(Contract F10602-85-C-0010; AF-AFOSR-0255-82; NSF MCS-83-05032)
Avail: NTIS HC A18/MF A01 CSCL 09B

The current generation of languages for the construction of knowledge-based systems as being at too low a level of abstraction is criticized, and the need for higher level languages for building problem solving systems is advanced. A notion of generic information processing tasks in knowledge-based problem solving is introduced. A toolset which can be used to build expert systems in a way that enhances intelligibility and productivity in knowledge acquistion and system construction is described. The power of these ideas is illustrated by paying special attention to a high level language called DSPL. A description is given of how it was used in the construction of a system called MPA, which assists with planning in the domain of offensive counter air missions. Author

N89-26548*# Minnesota Univ., Minneapolis.
MONITORING ROBOT ACTIONS FOR ERROR DETECTION AND RECOVERY
M. Gini and R. Smith *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 67-78 (For primary document see N89-26541 20-63)
(Grant NSF DMC-85-18735)
Avail: NTIS HC A18/MF A01 CSCL 09B

Reliability is a serious problem in computer controlled robot systems. Although robots serve successfully in relatively simple applications such as painting and spot welding, their potential in areas such as automated assembly is hampered by programming problems. A program for assembling parts may be logically correct, execute correctly on a simulator, and even execute correctly on a robot most of the time, yet still fail unexpectedly in the face of real world uncertainties. Recovery from such errors is far more complicated than recovery from simple controller errors, since even expected errors can often manifest themselves in unexpected ways. Here, a novel approach is presented for improving robot reliability. Instead of anticipating errors, researchers use knowledge-based

programming techniques so that the robot can autonomously exploit knowledge about its task and environment to detect and recover from failures. They describe preliminary experiment of a system that they designed and constructed. Author

N89-26549*# Stanford Research Inst., Menlo Park, CA.
RECOVERING FROM EXECUTION ERRORS IN SIPE
D. E. Wilkins *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 79-90 Submitted for publication (For primary document see N89-26541 20-63)
(Contract F40620-79-C-0188)
Avail: NTIS HC A18/MF A01 CSCL 09B

In real-world domains (e.g., a mobile robot environment), things do not always proceed as planned, so it is important to develop better execution-monitoring techniques and replanning capabilities. These capabilities in the SIPE planning system are described. The motivation behind SIPE is to place enough limitations on the representation so that planning can be done efficiently, while retaining sufficient power to still be useful. This work assumes that new information given to the execution monitor is in the form of predicates, thus avoiding the difficult problem of how to generate these predicates from information provided by sensors. The replanning module presented here takes advantage of the rich structure of SIPE plans and is intimately connected with the planner, which can be called as a subroutine. This allows the use of SIPE's capabilities to determine efficiently how unexpected events affect the plan being executed and, in many cases, to retain most of the original plan by making changes in it to avoid problems caused by these unexpected events. SIPE is also capable of shortening the original plan when serendipitous events occur. A general set of replanning actions is presented along with a general replanning capability that has been implemented by using these actions. Author

N89-26550*# Massachusetts Univ., Amherst.
INCREMENTAL PLANNING TO CONTROL A BLACKBOARD-BASED PROBLEM SOLVER
E. H. Durfee and V. R. Lesser *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 91-99 (For primary document see N89-26541 20-63)
(Grants NSF MCS-83-06327; NSF DCR-83-18776; NSF DCR-85-00332; NR Proj. 049041)
Avail: NTIS HC A18/MF A01 CSCL 09B

To control problem solving activity, a planner must resolve uncertainty about which specific long-term goals (solutions) to pursue and about which sequences of actions will best achieve those goals. A planner is described that abstracts the problem solving state to recognize possible competing and compatible solutions and to roughly predict the importance and expense of developing these solutions. With this information, the planner plans sequences of problem solving activities that most efficiently resolve its uncertainty about which of the possible solutions to work toward. The planner only details actions for the near future because the results of these actions will influence how (and whether) a plan should be pursued. As problem solving proceeds, the planner adds new details to the plan incrementally, and monitors and repairs the plan to insure it achieves its goals whenever possible. Through experiments, researchers illustrate how these new mechanisms significantly improve problem solving decisions and reduce overall computation. They briefly discuss current research directions, including how these mechanisms can improve a problem solver's real-time response and can enhance cooperation in a distributed problem solving network. Author

N89-26551*# Minnesota Univ., Minneapolis.
KNOWLEDGE REPRESENTATION SYSTEM FOR ASSEMBLY USING ROBOTS **c37**
A. Jain and M. Donath *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 101-113 (For primary document see N89-26541 20-63)
(Grant NSF DMC-83-51827)
Avail: NTIS HC A18/MF A01 CSCL 13I

Assembly robots combine the benefits of speed and accuracy with the capability of adaptation to changes in the work environment. However, an impediment to the use of robots is the complexity of the man-machine interface. This interface can be improved by providing a means of using a priori-knowledge and reasoning capabilities for controlling and monitoring the tasks performed by robots. Robots ought to be able to perform complex assembly tasks with the help of only supervisory guidance from human operators. For such supervisory guidance, it is important to express the commands in terms of the effects desired, rather than in terms of the motion the robot must undertake in order to achieve these effects. A suitable knowledge representation can facilitate the conversion of task level descriptions into explicit instructions to the robot. Such a system would use symbolic relationships describing the a priori information about the robot, its environment, and the tasks specified by the operator to generate the commands for the robot. Author

N89-26552*# McGill Univ., Montreal (Quebec).
THE USE OF 3-D SENSING TECHNIQUES FOR ON-LINE COLLISION-FREE PATH PLANNING
V. Hayward, S. Aubry, and Z. Jasiukajc *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 119-123 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

The state of the art in collision prevention for manipulators with revolute joints, showing that it is a particularly computationally hard problem, is discussed. Based on the analogy with other hard or undecidable problems such as theorem proving, an extensible multi-resolution architecture for path planning, based on a collection of weak methods is proposed. Finally, the role that sensors can play for an on-line use of sensor data is examined. Author

N89-26553*# University of Southern Illinois, Carbondale.
COLLISION-FREE TRAJECTORY PLANNING ALGORTHM FOR MANIPULATORS
F. Pourboghrat and J. Y. Han *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 125-127 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Collision-free trajectory planning for robotic manipulators is investigated. The task of the manipulator is to move its end-effector from one point to another point in an environment with polyhedral obstacles. An on-line algorithm is developed based on finding the required joint angles of the manipulator, according to goals with different priorities. The highest priority is to avoid collisions, the second priority is to plan the shortest path for the end effector, and the lowest priority is to minimize the joint velocity for smooth motion. The pseudo-inverse of the Jacobian matrix is applied for inverse kinematics. When a possible collision is detected, a constrained inverse kinematic problem is solved such that the collision is avoided. This algorithm can also be applied to a time-variant environment. Author

N89-26554*# Carnegie-Mellon Univ., Pittsburgh, PA.
TASK PLANNING AND CONTROL SYNTHESIS FOR ROBOTIC MANIPULATION IN SPACE APPLICATIONS
A. C. Sanderson, M. A. Peshkin, and L. S. Homem-de-Mello *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 129-138 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Space-based robotic systems for diagnosis, repair and assembly of systems will require new techniques of planning and manipulation to accomplish these complex tasks. Results of work in assembly task representation, discrete task planning, and control synthesis which provide a design environment for flexible assembly systems in manufacturing applications, and which extend to planning of

manipulatiuon operations in unstructured environments are summarized. Assembly planning is carried out using the AND/OR graph representation which encompasses all possible partial orders of operations and may be used to plan assembly sequences. Discrete task planning uses the configuration map which facilitates search over a space of discrete operations parameters in sequential operations in order to achieve required goals in the space of bounded configuration sets. Author

N89-26555*# Massachusetts Inst. of Tech., Cambridge.
USING AUTOMATIC ROBOT PROGRAMMING FOR SPACE TELEROBOTICS
E. Mazer, J. Jones, A. Lanusse, T. Lozano-Perez, P. ODonnell, and P. Tournassoud *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 139-150 Sponsored in part by NSF; and by the Centre National de la Recherche Scientifique (France) (For primary document see N89-26541 20-63)
(Contract N00014-85-K-0214)
Avail: NTIS HC A18/MF A01 CSCL 09B

The interpreter of a task level robot programming system called Handey is described. Handey is a system that can recognize, manipulate and assemble polyhedral parts when given only a specification of the goal. To perform an assembly, Handey makes use of a recognition module, a gross motion planner, a grasp planner, a local approach planner and is capable of planning part re-orientation. The possibility of including these modules in a telerobotics work-station is discussed. Author

N89-26556*# Purdue Univ., West Lafayette, IN.
ADAPTIVE FORCE-POSITION CONTROL FOR TELEOPERATED MANIPULATORS
A. J. Koivo *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 155-157 (For primary document see N89-26541 20-63)
(Grant NSF CDR-85-00022)
Avail: NTIS HC A18/MF A01 CSCL 09B

An adaptive controller with self-tuning can be designed for teleoperated robotic manipulators by determining a time-series model for the function of the teleoperator. Specifically, the position and force exerted by the operator are modelled for determining the derived values for the trajectory of the end-effector of the manipulator. Thus, the adaptive controller can be designed by following the steps which have previously been presented for the controller design of the gross motion. Author

N89-26557*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ADAPTIVE CONTROL OF DUAL-ARM ROBOTS
H. Seraji *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 159-170 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Three strategies for adaptive control of cooperative dual-arm robots are described. In the position-position control strategy, the adaptive controllers ensure that the end-effector positions of both arms track desired trajectories in Cartesian space despite unknown time-varying interaction forces exerted through the load. In the position-hybrid control strategy, the adaptive controller of one arm controls end-effector motions in the free directions and applied forces in the constraint directions, while the adaptive controller of the other arm ensures that the end-effector tracks desired position trajectories. In the hybrid-hybrid control strategy, the adaptive controllers ensure that both end-effectors track reference position trajectories while simultaneously applying desired forces on the load. In all three control strategies, the cross-coupling effects between the arms are treated as disturbances which are rejected by the adaptive controllers while following desired commands in a common frame of reference. The adaptive controllers do not require the complex mathematical model of the arm dynamics or any knowledge of the arm dynamic parameters or the load parameters such as mass and stiffness. The controllers have simple structures and are computationally fast for on-line implementation with high sampling rates. Author

N89-26558*# Carnegie-Mellon Univ., Pittsburgh, PA.
DESIGN OF A RECONFIGURABLE MODULAR MANIPULATOR SYSTEM **c37**
D. Schmitz and T. Kanade *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 171-178 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

Using manipulators with a fixed configuration for specific tasks is appropriate when the task requirements are known beforehand. However, in less predictable situations, such as an outdoor construction site or aboard a space station, a manipulator system requires a wide range of capabilities, probably beyond the limitations of a single, fixed-configuration manipulator. To fulfill this need, researchers have been working on a Reconfigurable Modular Manipulator System (RMMS). Researchers have designed and are constructing a prototype RMMS. The prototype currently consists of two joint modules and four link modules. The joints utilize a conventional harmonic drive and torque motor actuator, with a small servo amplifier included in the assembly. A brushless resolver is used to sense the joint position and velocity. For coupling the modules together, a standard electrical connector and V-band clamps for mechanical connection are used, although more sophisticated designs are under way for future versions. The joint design yields an output torque to 50 ft-lbf at joint speeds up to 1 radian/second. The resolver and associated electronics have resolutions of 0.0001 radians, and absolute accuracies of plus or minus 0.001 radians. Manipulators configured from these prototype modules will have maximum reaches in the 0.5 to 2 meter range. The real-time RMMS controller consists of a Motorola 68020 single-board computer which will perform real time servo control and path planning of the manipulator. This single board computer communicates via shared memory with a SUN3 workstation, which serves as a software development system and robot programming environment. Researchers have designed a bus communication network to provide multiplexed communication between the joint modules and the computer controller. The bus supports identification of modules, sensing of joint states, and commands to the joint actuator. This network has sufficient bandwidth to allow servo sampling rates in excess of 500 Hz. Author

N89-26559*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NONLINEAR FEEDBACK CONTROL OF MULTIPLE ROBOT ARMS **c37**
T. J. Tarn, X. Yun (Washington Univ., Saint Louis, MO.), and A. K. Bejczy *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 179-191 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

Multiple coordinated robot arms are modeled by considering the arms: (1) as closed kinematic chains, and (2) as a force constrained mechanical system working on the same object simultaneously. In both formulations a new dynamic control method is discussed. It is based on a feedback linearization and simultaneous output decoupling technique. Applying a nonlinear feedback and a nonlinear coordinate transformation, the complicated model of the multiple robot arms in either formulation is converted into a linear and output decoupled system. The linear system control theory and optimal control theory are used to design robust controllers in the task space. The first formulation has the advantage of automatically handling the coordination and load distribution among the robot arms. In the second formulation, by choosing a general output equation, researchers can superimpose the position and velocity error feedback with the force-torque error feedback in the task space simultaneously. Author

N89-26560*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
DYNAMICS AND CONTROL OF COORDINATED MULTIPLE MANIPULATORS c37
S. A. Hayati *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 193-203 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

A technique is presented for controlling multiple manipulators which are holding a single object and therefore form a closed kinematic chain. The object, which may or may not be in contact with a rigid environment, is assumed to be held rigidly by robot end-effectors. The derivation is based on setting up constraint equations which reduce the 6 x n degrees of freedom of a manipulators each having six joints. Additional constraint equations are considered when one or more of the degrees of freedom of the object is reduced due to external constraints. Utilizing the operational space dynamics equations, a decoupling controller is designed to control both the position and the interaction forces of the object with the environment. Finally, simulation results for the control of a pair of two-link manipulators are presented. Author

N89-26561*# Texas Univ., Austin.
A SURVEY OF ADAPTIVE CONTROL TECHNOLOGY IN ROBOTICS
S. Tosunoglu and D. Tesar *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 205-214 Previously announced as N87-22426 (For primary document see N89-26541 20-63)
(Contract NAG9-188; DE-FG02-86NE-37966)
Avail: NTIS HC A18/MF A01 CSCL 09B

Previous work on the adaptive control of robotic systems is reviewed. Although the field is relatively new and does not yet represent a mature discipline, considerable attention has been given to the design of sophisticated robot controllers. Here, adaptive control methods are divided into model reference adaptive systems and self-tuning regulators with further definition of various approaches given in each class. The similarity and distinct features of the designed controllers are delineated and tabulated to enhance comparative review. Author

N89-26562*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SIMPLE ROBUST CONTROL LAWS FOR ROBOT MANIPULATORS. PART 1: NON-ADAPTIVE CASE
J. T. Wen and D. S. Bayard *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 215-229 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

A new class of exponentially stabilizing control laws for joint level control of robot arms is introduced. It has been recently recognized that the nonlinear dynamics associated with robotic manipulators have certain inherent passivity properties. More specifically, the derivation of the robotic dynamic equations from the Hamilton's principle gives rise to natural Lyapunov functions for control design based on total energy considerations. Through a slight modification of the energy Lyapunov function and the use of a convenient lemma to handle third order terms in the Lyapunov function derivatives, closed loop exponential stability for both the set point and tracking control problem is demonstrated. The exponential convergence property also leads to robustness with respect to frictions, bounded modeling errors and instrument noise. In one new design, the nonlinear terms are decoupled from real-time measurements which completely removes the requirement for on-line computation of nonlinear terms in the controller implementation. In general, the new class of control laws offers alternatives to the more conventional computed torque method, providing tradeoffs between robustness, computation and convergence properties. Furthermore, these control laws have the unique feature that they can be adapted in a very simple fashion to achieve asymptotically stable adaptive control. Author

N89-26563*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SIMPLE ROBUST CONTROL LAWS FOR ROBOT MANIPULATORS. PART 2: ADAPTIVE CASE
D. S. Bayard and J. T. Wen *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 231-243 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

A new class of asymptotically stable adaptive control laws is introduced for application to the robotic manipulator. Unlike most applications of adaptive control theory to robotic manipulators, this analysis addresses the nonlinear dynamics directly without approximation, linearization, or ad hoc assumptions, and utilizes a parameterization based on physical (time-invariant) quantities. This approach is made possible by using energy-like Lyapunov functions which retain the nonlinear character and structure of the dynamics, rather than simple quadratic forms which are ubiquitous to the adaptive control literature, and which have bound the theory tightly to linear systems with unknown parameters. It is a unique feature of these results that the adaptive forms arise by straightforward certainty equivalence adaptation of their nonadaptive counterparts found in the companion to this paper (i.e., by replacing unknown quantities by their estimates) and that this simple approach leads to asymptotically stable closed-loop adaptive systems. Furthermore, it is emphasized that this approach does not require convergence of the parameter estimates (i.e., via persistent excitation), invertibility of the mass matrix estimate, or measurement of the joint accelerations. Author

N89-26564*# Queensland Univ., Saint Lucia (Australia).
ALGORITHMS FOR ADAPTIVE CONTROL OF TWO-ARM FLEXIBLE MANIPULATORS UNDER UNCERTAINTY
J. M. Skowronski *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 245-253 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

A nonlinear extension of model reference adaptive control (MRAC) technique is used to guide a double arm nonlinearizable robot manipulator with flexible links, driven by actuators collocated with joints subject to uncertain payload and inertia. The objective is to track a given simple linear and rigid but compatible dynamical model in real, possible stipulated time and within stipulated degree of accuracy of convergence while avoiding collision of the arms. The objective is attained by a specified signal adaptive feedback controller and by adaptive laws, both given in closed form. A case of 4 DOF manipulator illustrates the technique. Author

N89-26565*# Pennsylvania Univ., Philadelphia.
PROBLEMS AND RESEARCH ISSUES ASSOCIATED WITH THE HYBRID CONTROL OF FORCE AND DISPLACEMENT
R. P. Paul *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 255-260 (For primary document see N89-26541 20-63)
(Grant NSF DMS-84-11879)
Avail: NTIS HC A18/MF A01 CSCL 09B

The hybrid control of force and position is basic to the science of robotics but is only poorly understood. Before much progress can be made in robotics, this problem needs to be solved in a robust manner. However, the use of hybrid control implies the existence of a model of the environment, not an exact model (as the function of hybrid control is to accommodate these errors), but a model appropriate for planning and reasoning. The monitored forces in position control are interpreted in terms of a model of the task as are the monitored displacements in force control. The reaction forces of the task of writing are far different from those of hammering. The programming of actions in such a modeled world becomes more complicated and systems of task level programming need to be developed. Sensor based robotics, of which force sensing is the most basic, implies an entirely new level of technology. Indeed, robot force sensors, no matter how compliant they may be, must be protected from accidental

collisions. This implies other sensors to monitor task execution and again the use of a world model. This new level of technology is the task level, in which task actions are specified, not the actions of individual sensors and manipulators. Author

N89-26566*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
ADAPTIVE HYBRID CONTROL OF MANIPULATORS
H. Seraji *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 261-271 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Simple methods for the design of adaptive force and position controllers for robot manipulators within the hybrid control architecuture is presented. The force controller is composed of an adaptive PID feedback controller, an auxiliary signal and a force feedforward term, and it achieves tracking of desired force setpoints in the constraint directions. The position controller consists of adaptive feedback and feedforward controllers and an auxiliary signal, and it accomplishes tracking of desired position trajectories in the free directions. The controllers are capable of compensating for dynamic cross-couplings that exist between the position and force control loops in the hybrid control architecture. The adaptive controllers do not require knowledge of the complex dynamic model or parameter values of the manipulator or the environment. The proposed control schemes are computationally fast and suitable for implementation in on-line control with high sampling rates. Author

N89-26567*# University of Southern Illinois, Carbondale.
ADAPTIVE HYBRID POSITION/FORCE CONTROL OF ROBOTIC MANIPULATORS **c37**
F. Pourboghrat *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 273-277 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

The problem of position and force control for the compliant motion of the manipulators is considered. The external force and the position of the end-effector are related by a second order impedance function. The force control problem is then translated into a position control problem. For that, an adaptive controller is designed to achieve the compliant motion. The design uses the Liapunov's direct method to derive the adaptation law. The stability of the process is guaranteed from the Liapunov's stability theory. The controller does not require the knowledge of the system parameters for the implementation, and hence is easy for applications. Author

N89-26568*# Ohio State Univ., Columbus.
FLEXIBLE MANIPULATOR CONTROL EXPERIMENTS AND ANALYSIS
S. Yurkovich, U. Ozguner, A. Tzes, and P. T. Kotnik *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 279-287 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Modeling and control design for flexible manipulators, both from an experimental and analytical viewpoint, are described. From the application perspective, an ongoing effort within the laboratory environment at the Ohio State University, where experimentation on a single link flexible arm is underway is described. Several unique features of this study are described here. First, the manipulator arm is slewed by a direct drive dc motor and has a rigid counterbalance appendage. Current experimentation is from two viewpoints: (1) rigid body slewing and vibration control via actuation with the hub motor, and (2) vibration suppression through the use of structure-mounted proof-mass actuation at the tip. Such an application to manipulator control is of interest particularly in design of space-based telerobotic control systems, but has received little attention to date. From an analytical viewpoint, parameter estimation techniques within the closed-loop for self-tuning adaptive control approaches are discussed. Also introduced is a control approach based on output feedback and frequency weighting to counteract effects of spillover in reduced-order model design. A model of the flexible manipulator based on experimental measurements is evaluated for such estimation and control approaches. Author

N89-26569*# Ohio State Univ., Columbus.
DUAL ARM ROBOTIC SYSTEM WITH SENSORY INPUT **c37**
U. Ozguner *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 289-297 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

The need for dual arm robots in space station assembly and satellite maintainance is of increasing significance. Such robots will be in greater demand in the future when numerous tasks will be assigned to them to relieve the direct intervention of humans in space. Technological demands from these robots will be high. They will be expected to perform high speed tasks with a certain degree of autonomy. Various levels of sensing will have to be used in a sophisticated control scheme. Ongoing research in control, sensing and real-time software to produce a two-arm robotic system than can accomplish generic assembly tasks is discussed. The control hierarchy and the specific control approach are discussed. A decentralized implementation of model-reference adaptive control using Variable Structure controllers and the incorporation of tactile feedback is considered. Author

N89-26570*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
GEOMETRIC FOUNDATIONS OF THE THEORY OF FEEDBACK EQUIVALENCE
R. Hermann *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 299-306 (For primary document see N89-26541 20-63)
(Grant NAG2-406)
Avail: NTIS HC A18/MF A01 CSCL 09B

A description of feedback control is presented within the context of differential equations, differential geometry, and Lie theory. Work related to the integration of differential geometry with the control techniques of feedback linearization is summarized. Particular attention is given to the application of the theory of vector field systems. Feedback invariants for control systems in state space form are also addressed. M.G.

N89-26571*# Old Dominion Univ., Norfolk, VA.
REDUCING MODEL UNCERTAINTY EFFECTS IN FLEXIBLE MANIPULATORS THROUGH THE ADDITION OF PASSIVE DAMPING **c37**
T. E. Alberts *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 307-316 Prepared in cooperation with Georgia Inst. of Tec h., Atlanta (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

An important issue in the control of practical systems is the effect of model uncertainty on closed loop performance. This is of particular concern when flexible structures are to be controlled, due to the fact that states associated with higher frequency vibration modes are truncated in order to make the control problem tractable. Digital simulations of a single-link manipulator system are employed to demonstrate that passive damping added to the flexible member reduces adverse effects associated with model uncertainty. A controller was designed based on a model including only one flexible mode. This controller was applied to larger order systems to evaluate the effects of modal truncation. Simulations using a Linear Quadratic Regulator (LQR) design assuming full state feedback illustrate the effect of control spillover. Simulations of a system using output feedback illustrate the destabilizing effect of observation spillover. The simulations reveal that the system with passive damping is less susceptible to these effects than the untreated case. Author

N89-26572*# California Univ., Davis.
PARALLEL PROCESSING ARCHITECTURE FOR COMPUTING INVERSE DIFFERENTIAL KINEMATIC EQUATIONS OF THE PUMA ARM **c61**
T. C. Hsia, G. Z. Lu, and W. H. Han (Nankai Univ., Tiangjin, China) *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 317-324 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

In advanced robot control problems, on-line computation of inverse Jacobian solution is frequently required. Parallel processing architecture is an effective way to reduce computation time. A parallel processing architecture is developed for the inverse Jacobian (inverse differential kinematic equation) of the PUMA arm. The proposed pipeline/parallel algorithm can be inplemented on an IC chip using systolic linear arrays. This implementation requires 27 processing cells and 25 time units. Computation time is thus significantly reduced. Author

N89-26573*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
MANIPULATOR CONTROL BY EXACT LINEARIZATION
K. Kruetz *In its* Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 325-334 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 09B

Comments on the application to rigid link manipulators of geometric control theory, resolved acceleration control, operational space control, and nonlinear decoupling theory are given, and the essential unity of these techniques for externally linearizing and decoupling end effector dynamics is discussed. Exploiting the fact that the mass matrix of a rigid link manipulator is positive definite, a consequence of rigid link manipulators belonging to the class of natural physical systems, it is shown that a necessary and sufficient condition for a locally externally linearizing and output decoupling feedback law to exist is that the end effector Jacobian matrix be nonsingular. Furthermore, this linearizing feedback is easy to produce. Author

N89-26574*# Massachusetts Inst. of Tech., Cambridge.
A VIRTUAL MANIPULATOR MODEL FOR SPACE ROBOTIC SYSTEMS **c37**
S. Dubowsky and Z. Vafa *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 342-344 (For primary document see N89-26541 20-63)
(Grant NAG1-489)
Avail: NTIS HC A18/MF A01 CSCL 13I

Future robotic manipulators carried by a spacecraft will be required to perform complex tasks in space, like repairing satellites. Such applications of robotic manipulators will encounter a number of kinematic, dynamic and control problems due to the dynamic coupling between the manipulators and the spacecraft. A new analytical modeling method for studying the kinematics and dynamics of manipulators in space is presented. The problem is treated by introducing the concept of a Virtual Manipulator (VM). The kinematic and dynamic motions of the manipulator, vehicle and payload, can be described relatively easily in terms of the Virtual Manipulator movements, which have a fixed base in inertial space at a point called a Virtual Ground. It is anticipated that the approach described here will aid in the design and development of future space manipulator systems. Author

N89-26575*# Purdue Univ., West Lafayette, IN.
MODEL REDUCTION FOR DISCRETE BILINEAR SYSTEMS **c37**
A. M. King and R. E. Skelton *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 345-354 Sponsored in part by Hughes Aircraft Company (For primary document see N89-26541 20-63)
(Grant NSF MEA-84-05133)
Avail: NTIS HC A18/MF A01 CSCL 13I

A model reduction method for discrete bilinear systems is developed which matches q sets of Volterra and covariance parameters. These parameters are shown to represent both deterministic and stochastic attributes of the discrete bilinear system. A reduced order model which matches these q sets of parameters is defined to be a q-Volterra covariance equivalent realization (q-Volterra COVER). An algorithm is presented which constructs a class of q-Volterra COVERs parameterized by solutions to a Hermitian, quadratic, matrix equation. The algorithm is applied to a bilinear model of a robot manipulator. Author

N89-26576*# Yale Univ., New Haven, CT.
HIGH GAIN FEEDBACK AND TELEROBOTIC TRACKING
D. E. Koditschek *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 355-361 (For primary document see N89-26541 20-63)
(Grant NSF DMS-85-05160)
Avail: NTIS HC A18/MF A01 CSCL 09B

Asymptotically stable linear time invariant systems are capable of tracking arbitrary reference signals with a bounded error proportional to the magnitude of the reference signal (and its derivatives). It is shown that a similar property holds for a general class of nonlinear dynamical systems which includes all robots. As in the linear case, the error bound may be made arbitrarily small by increasing the magnitude of the feedback gains which stabilize the system. Author

N89-26577*# Ametek, Inc., Santa Barbara, CA.
CONCEPT DEVELOPMENT OF A TENDON ARM MANIPULATOR AND ANTHROPOMORPHIC ROBOTIC HAND **c37**
C. T. Tolman *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 3 1 Jul. 1987 p 365-371 (For primary document see N89-26541 20-63)
Avail: NTIS HC A18/MF A01 CSCL 13I

AMETEK/ORED inhouse research and development efforts leading toward a next-generation robotic manipulator arm and end-effector technology is summarized. Manipulator arm development has been directed toward a multiple-degree-of-freedom, flexible, tendon-driven concept referred to here as a Tendon Arm Manipulator (TAM). End-effector development has been directed toward a three-fingered, dextrous, tendon-driven, anthropomorphic configuration which is referred to as an Anthropomorphic Robotic Hand (ARH). Key technology issues are identified for both concepts. Author

N89-26578*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE 1989 GODDARD CONFERENCE ON SPACE APPLICATIONS OF ARTIFICIAL INTELLIGENCE
James Rash, ed. Washington Apr. 1989 385 p Conference held in Greenbelt, MD, 16-17 May 1989
(NASA-CP-3033; Rept-89B00099; NAS 1.55:3033) Avail: NTIS HC A17/MF A01 CSCL 09B

The following topics are addressed: mission operations support; planning and scheduling; fault isolation/diagnosis; image processing and machine vision; data management; and modeling and simulation. For individual titles, see N89-26579 through N89-26607.

N89-26579*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
KNOWLEDGE BASED AND INTERACTIVE CONTROL FOR THE SUPERFLUID HELIUM ON-ORBIT TRANSFER PROJECT
Timothy P. Castellano, Eric A. Raymond, Jeff C. Shapiro, Frank A. Robinson (Sterling Software, Palo Alto, CA.), and Donald A. Rosenthal *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 3-11 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

NASA's Superfluid Helium On-Orbit Transfer (SHOOT) project is a Shuttle-based experiment designed to acquire data on the properties of superfluid helium in micro-gravity. Aft Flight Deck Computer Software for the SHOOT experiment is comprised of several monitoring programs which give the astronaut crew visibility into SHOOT systems and a rule based system which will provide process control, diagnosis and error recovery for a helium transfer without ground intervention. Given present Shuttle manifests, this software will become the first expert system to be used in space. The SHOOT Command and Monitoring System (CMS) software will provide a near real time highly interactive interface for the SHOOT principal investigator to control the experiment and to analyze and display its telemetry. The CMS software is targeted for all phases of the SHOOT project: hardware development, pre-flight pad servicing, in-flight operations, and post-flight data analysis. Author

N89-26580*# Maryland Univ., College Park. Dept. of Computer Science.

SHARED RESOURCE CONTROL BETWEEN HUMAN AND COMPUTER

James Hendler and Reid Wilson *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 13-19 Sponsored by part by ONR, Washington, DC (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

The advantages of an AI system of actively monitoring human control of a shared resource (such as a telerobotic manipulator) are presented. A system is described in which a simple AI planning program gains efficiency by monitoring human actions and recognizing when the actions cause a change in the system's assumed state of the world. This enables the planner to recognize when an interaction occurs between human actions and system goals, and allows maintenance of an up-to-date knowledge of the state of the world and thus informs the operator when human action would undo a goal achieved by the system, when an action would render a system goal unachievable, and efficiently replans the establishment of goals after human intervention. Author

N89-26581*# Unisys Corp., Lanham, MD.

AN ENGLISH LANGUAGE INTERFACE FOR CONSTRAINED DOMAINS

Brenda J. Page *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 21-34 (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

The Multi-Satellite Operations Control Center (MSOCC) Jargon Interpreter (MJI) demonstrates an English language interface for a constrained domain. A constrained domain is defined as one with a small and well delineated set of actions and objects. The set of actions chosen for the MJI is from the domain of MSOCC Applications Executive (MAE) Systems Test and Operations Language (STOL) directives and contains directives for signing a cathode ray tube (CRT) on or off, calling up or clearing a display page, starting or stopping a procedure, and controlling history recording. The set of objects chosen consists of CRTs, display pages, STOL procedures, and history files. Translation from English sentences to STOL directives is done in two phases. In the first phase, an augmented transition net (ATN) parser and dictionary are used for determining grammatically correct parsings of input sentences. In the second phase, grammatically typed sentences are submitted to a forward-chaining rule-based system for interpretation and translation into equivalent MAE STOL directives. Tests of the MJI show that it is able to translate individual clearly stated sentences into the subset of directives selected for the prototype. This approach to an English language interface may be used for similarly constrained situations by modifying the MJI's dictionary and rules to reflect the change of domain. Author

N89-26582*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

GROUND DATA SYSTEMS RESOURCE ALLOCATION PROCESS

Carol A. Berner, Ralph Durham, and Norman B. Reilly *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 37-47 (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

The Ground Data Systems Resource Allocation Process at the Jet Propulsion Laboratory provides medium- and long-range planning for the use of Deep Space Network and Mission Control and Computing Center resources in support of NASA's deep space missions and Earth-based science. Resources consist of radio antenna complexes and associated data processing and control computer networks. A semi-automated system was developed that allows operations personnel to interactively generate, edit, and revise allocation plans spanning periods of up to ten years (as opposed to only two or three weeks under the manual system) based on the relative merit of mission events. It also enhances scientific data return. A software system known as the Resource Allocation and Planning Helper (RALPH) merges the conventional methods of operations research, rule-based knowledge engineering, and advanced data base structures. RALPH employs a generic, highly modular architecture capable of solving a wide variety of scheduling and resource sequencing problems. The rule-based RALPH system has saved significant labor in resource allocation. Its successful use affirms the importance of establishing and applying event priorities based on scientific merit, and the benefit of continuity in planning provided by knowledge-based engineering. The RALPH system exhibits a strong potential for minimizing development cycles of resource and payload planning systems throughout NASA and the private sector. Author

N89-26583*# Mitre Corp., McLean, VA.

A SITUATED REASONING ARCHITECTURE FOR SPACE-BASED REPAIR AND REPLACE TASKS

Ben Bloom, Debra McGrath, and Jim Sanborn *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 49-59 (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

Space-based robots need low level control for collision detection and avoidance, short-term load management, fine-grained motion, and other physical tasks. In addition, higher level control is required to focus strategic decision making as missions are assigned and carried out. Reasoning and control must be responsive to ongoing changes in the environment. Research aimed at bridging the gap between high level artificial intelligence (AI) planning techniques and task-level robot programming for telerobotic systems is described. Situated reasoning is incorporated into AI and Robotics systems in order to coordinate a robot's activity within its environment. An integrated system under development in a component maintenance domain is described. It is geared towards replacing worn and/or failed Orbital Replacement Units (ORUs) designed for use aboard NASA's Space Station Freedom based on the collection of components available at a given time. High level control reasons in component space in order to maximize the number operational component-cells over time, while the task-level controls sensors and effectors, detects collisions, and carries out pick and place tasks in physical space. Situated reasoning is used throughout the system to cope with component failures, imperfect information, and unexpected events. Author

N89-26584*# Maryland Univ., College Park. Dept. of Computer Science.

PARALLEL PLAN EXECUTION WITH SELF-PROCESSING NETWORKS **c62**

C. Lynne DAutrechy and James A. Reggia *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 61-73 (For

primary document see N89-26578 20-63)
(Grants NAG1-885; NSF IRI-84-51430)
Avail: NTIS HC A17/MF A01 CSCL 09B

A critical issue for space operations is how to develop and apply advanced automation techniques to reduce the cost and complexity of working in space. In this context, it is important to examine how recent advances in self-processing networks can be applied for planning and scheduling tasks. For this reason, the feasibility of applying self-processing network models to a variety of planning and control problems relevant to spacecraft activities is being explored. Goals are to demonstrate that self-processing methods are applicable to these problems, and that MIRRORS/II, a general purpose software environment for implementing self-processing models, is sufficiently robust to support development of a wide range of application prototypes. Using MIRRORS/II and marker passing modelling techniques, a model of the execution of a Spaceworld plan was implemented. This is a simplified model of the Voyager spacecraft which photographed Jupiter, Saturn, and their satellites. It is shown that plan execution, a task usually solved using traditional artificial intelligence (AI) techniques, can be accomplished using a self-processing network. The fact that self-processing networks were applied to other space-related tasks, in addition to the one discussed here, demonstrates the general applicability of this approach to planning and control problems relevant to spacecraft activities. It is also demonstrated that MIRRORS/II is a powerful environment for the development and evaluation of self-processing systems. Author

N89-26585*# Centre d'Etudes et de Recherches, Toulouse (France). Groupement d'Intelligence Artificielle.
MISSION SCHEDULING
Christine Gaspin *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 75-86 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

How a neural network can work, compared to a hybrid system based on an operations research and artificial intelligence approach, is investigated through a mission scheduling problem. The characteristic features of each system are discussed. Author

N89-26586*# AI Atlanta, Inc., Decatur, GA.
ON THE DEVELOPMENT OF A REACTIVE SENSOR-BASED ROBOTIC SYSTEM
Henry H. Hexmoor and William E. Underwood, Jr. *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 87-100 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

Flexible robotic systems for space applications need to use local information to guide their action in uncertain environments where the state of the environment and even the goals may change. They have to be tolerant of unexpected events and robust enough to carry their task to completion. Tactical goals should be modified while maintaining strategic goals. Furthermore, reactive robotic systems need to have a broader view of their environments than sensory-based systems. An architecture and a theory of representation extending the basic cycles of action and perception are described. This scheme allows for dynamic description of the environment and determining purposive and timely action. Applications of this scheme for assembly and repair tasks using a Universal Machine Intelligence RTX robot are being explored, but the ideas are extendable to other domains. The nature of reactivity for sensor-based robotic systems and implementation issues encountered in developing a prototype are discussed. Author

N89-26587*# Bendix Field Engineering Corp., Seabrook, MD. Software and Engineering Services.
PST AND PARR: PLAN SPECIFICATION TOOLS AND A PLANNING AND RESOURCE REASONING SHELL FOR USE IN SATELLITE MISSION PLANNING
David McLean and Wen Yen *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 101-112 (For primary document see N89-26578 20-63)
(Contracts NAS5-31000; NAS5-27772)
Avail: NTIS HC A17/MF A01 CSCL 09B

Plan Specification Tools (PST) are tools that allow the user to specify satellite mission plans in terms of satellite activities, relevent orbital events, and targets for observation. The output of these tools is a set of knowledge bases and environmental events which can then be used by a Planning And Resource Reasoning (PARR) shell to build a schedule. PARR is a reactive planning shell which is capable of reasoning about actions in the satellite mission planning domain. Each of the PST tools and PARR are described as well as the use of PARR for scheduling computer usage in the multisatellite operations control center at Goddard Space Flight Center. Author

N89-26588*# McDonnell-Douglas Space Systems Co., Cocoa Beach, FL.
AN APPROACH TO KNOWLEDGE ENGINEERING TO SUPPORT KNOWLEDGE-BASED SIMULATION OF PAYLOAD GROUND PROCESSING AT THE KENNEDY SPACE CENTER **c81**
Shawn McManus and Michael McDaniel *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 113-125 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 05A

Planning for processing payloads was always difficult and time-consuming. With the advent of Space Station Freedom and its capability to support a myriad of complex payloads, the planning to support this ground processing maze involves thousands of man-hours of often tedious data manipulation. To provide the capability to analyze various processing schedules, an object oriented knowledge-based simulation environment called the Advanced Generic Accomodations Planning Environment (AGAPE) is being developed. Having nearly completed the baseline system, the emphasis in this paper is directed toward rule definition and its relation to model development and simulation. The focus is specifically on the methodologies implemented during knowledge acquisition, analysis, and representation within the AGAPE rule structure. A model is provided to illustrate the concepts presented. The approach demonstrates a framework for AGAPE rule development to assist expert system development. Author

N89-26589*# Ford Aerospace and Communications Corp., Seabrook, MD. Space Systems Engineering Operation.
A HEURISTIC APPROACH TO INCREMENTAL AND REACTIVE SCHEDULING **c81**
Jide B. Odubiyi and David R. Zoch *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 127-140 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 05A

An heuristic approach to incremental and reactive scheduling is described. Incremental scheduling is the process of modifying an existing schedule if the initial schedule does not meet its stated initial goals. Reactive scheduling occurs in near real-time in response to changes in available resources or the occurrence of targets of opportunity. Only minor changes are made during both incremental and reactive scheduling because a goal of re-scheduling procedures is to minimally impact the schedule. The described heuristic search techniques, which are employed by the Request Oriented Scheduling Engine (ROSE), a prototype generic scheduler, efficiently approximate the cost of reaching a goal from a given state and effective mechanisms for controlling search. Author

N89-26590*# Office National d'Etudes et de Recherches Aerospatiales, Toulouse (France).
A METHOD FOR INTERACTIVE SATELLITE FAILURE DIAGNOSIS: TOWARDS A CONNECTIONIST SOLUTION **c18**
P. Bourret and James A. Reggia (Maryland Univ., College Park.)

In NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 143-152 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 22B

Various kinds of processes which allow one to make a diagnosis are analyzed. The analyses then focuses on one of these processes used for satellite failure diagnosis. This process consists of sending the satellite instructions about system status alterations: to mask the effects of one possible component failure or to look for additional abnormal measures. A formal model of this process is given. This model is an extension of a previously defined connectionist model which allows computation of ratios between the likelihoods of observed manifestations according to various diagnostic hypotheses. The expected mean value of these likelihood measures for each possible status of the satellite can be computed in a similar way. Therefore, it is possible to select the most appropriate status according to three different purposes: to confirm an hypothesis, to eliminate an hypothesis, or to choose between two hypotheses. Finally, a first connectionist schema of computation of these expected mean values is given. Author

N89-26591*# Computer Sciences Corp., Beltsville, MD.
BCAUS PROJECT DESCRIPTION AND CONSIDERATION OF SEPARATION OF DATA AND CONTROL
Joy L. Bush and Steven J. Weaver *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 153-160 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

The commonly stated truths that data may be segregated from program control in generic expert system shells and that such tools support straightforward knowledge representation were examined. The ideal of separation of data from program control in expert systems is difficult to realize for a variety of reasons. One approach to achieving this goal is to integrate hybrid collections of specialized shells and tools instead of producing custom systems built with a single all purpose expert system tool. Aspects of these issues are examined in the context of a specific diagnostic expert system application, the Backup Control Mode Analysis and Utility System (BCAUS), being developed for the Gamma Ray Observatory (GRO) spacecraft. The project and the knowledge gained in working on the project are described. Author

N89-26592*# Westinghouse Electric Corp., Baltimore, MD.
TRACKING AND DATA RELAY SATELLITE FAULT ISOLATION AND CORRECTION USING PACES: POWER AND ATTITUDE CONTROL EXPERT SYSTEM **c18**
Carol-Lee Erikson and Peggy Hooker (McDonnell-Douglas Space Systems Co., Cocoa Beach, FL.) *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 161-168 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 22B

The Power and Attitude Control Expert System (PACES) is an object oriented and rule based expert system which provides spacecraft engineers with assistance in isolating and correcting problems within the Power and Attitude Control Subsystems of the Tracking and Data Relay Satellites (TDRS). PACES is designed to act in a consultant role. It will not interface to telemetry data, thus preserving full operator control over spacecraft operations. The spacecraft engineer will input requested information. This information will include telemetry data, action being performed, problem characteristics, spectral characteristics, and judgments of spacecraft functioning. Questions are answered either by clicking on appropriate responses (for text), or entering numeric values. A context sensitive help facility allows access to additional information when the user has difficulty understanding a question or deciding on an answer. The major functionality of PACES is to act as a knowledge rich system which includes block diagrams, text, and graphics, linked using hypermedia techniques. This allows easy movement among pieces of the knowledge. Considerable documentation of the spacecraft Power and Attitude Control Subsystems is embedded within PACES. The development phase of TDRSS expert system technology is intended to provide NASA with the necessary expertise and capability to define requirements, evaluate proposals, and monitor the development progress of a highly competent expert system for NASA's Tracking and Data Relay Satellite Program. Author

N89-26593*# General Electric Co., Houston, TX. Mission Integration Office.
SPACELAB LIFE SCIENCES-1 ELECTRICAL DIAGNOSTIC EXPERT SYSTEM **c33**
C. Y. Kao and W. S. Morris *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 169-183 (For primary document see N89-26578 20-63)
(Contract NAS9-17884)
Avail: NTIS HC A17/MF A01 CSCL 09C

The Spacelab Life Sciences-1 (SLS-1) Electrical Diagnostic (SLED) expert system is a continuous, real time knowledge-based system to monitor and diagnose electrical system problems in the Spacelab. After fault isolation, the SLED system provides corrective procedures and advice to the ground-based console operator. The SLED system updates its knowledge about the status of Spacelab every 3 seconds. The system supports multiprocessing of malfunctions and allows multiple failures to be handled simultaneously. Information which is readily available via a mouse click includes: general information about the system and each component, the electrical schematics, the recovery procedures of each malfunction, and an explanation of the diagnosis. Author

N89-26594*# Jet Propulsion Lab., California Inst. of Tech., Pasadena. Artificial Intelligence Group.
SHARP: A MULTI-MISSION AI SYSTEM FOR SPACECRAFT TELEMETRY MONITORING AND DIAGNOSIS **c17**
Denise L. Lawson and Mark L. James *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 185-200 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09F

The Spacecraft Health Automated Reasoning Prototype (SHARP) is a system designed to demonstrate automated health and status analysis for multi-mission spacecraft and ground data systems operations. Telecommunications link analysis of the Voyager II spacecraft is the initial focus for the SHARP system demonstration which will occur during Voyager's encounter with the planet Neptune in August, 1989, in parallel with real-time Voyager operations. The SHARP system combines conventional computer science methodologies with artificial intelligence techniques to produce an effective method for detecting and analyzing potential spacecraft and ground systems problems. The system performs real-time analysis of spacecraft and other related telemetry, and is also capable of examining data in historical context. A brief introduction is given to the spacecraft and ground systems monitoring process at the Jet Propulsion Laboratory. The current method of operation for monitoring the Voyager Telecommunications subsystem is described, and the difficulties associated with the existing technology are highlighted. The approach taken in the SHARP system to overcome the current limitations is also described, as well as both the conventional and artificial intelligence solutions developed in SHARP. Author

N89-26595*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
REDEX: THE RANGING EQUIPMENT DIAGNOSTIC EXPERT SYSTEM **c17**
Edward C. Luczak, K. Gopalakrishnan (Computer Sciences Corp., Beltsville, MD.), and David J. Zillig *In its* The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 201-211 (For primary document see N89-26578 20-63)
(Contract NAS5-31500)
Avail: NTIS HC A17/MF A01 CSCL 09F

REDEX, an advanced prototype expert system that diagnoses

hardware failures in the Ranging Equipment (RE) at NASA's Ground Network tracking stations is described. REDEX will help the RE technician identify faulty circuit cards or modules that must be replaced, and thereby reduce troubleshooting time. It features a highly graphical user interface that uses color block diagrams and layout diagrams to illustrate the location of a fault. A semantic network knowledge representation technique was used to model the design structure of the RE. A catalog of generic troubleshooting rules was compiled to represent heuristics that are applied in diagnosing electronic equipment. Specific troubleshooting rules were identified to represent additional diagnostic knowledge that is unique to the RE. Over 50 generic and 250 specific troubleshooting rules have been derived. REDEX is implemented in Prolog on an IBM PC AT-compatible workstation. Block diagram graphics displays are color-coded to identify signals that have been monitored or inferred to have nominal values, signals that are out of tolerance, and circuit cards and functions that are diagnosed as faulty. A hypertext-like scheme is used to allow the user to easily navigate through the space of diagrams and tables. Over 50 graphic and tabular displays have been implemented. REDEX is currently being evaluated in a stand-alone mode using simulated RE fault scenarios. It will soon be interfaced to the RE and tested in an online environment. When completed and fielded, REDEX will be a concrete example of the application of expert systems technology to the problem of improving performance and reducing the lifecycle costs of operating NASA's communications networks in the 1990's. Author

N89-26596*# Boeing Computer Services Co., Seattle, WA.
DIAGNOSTIC TOLERANCE FOR MISSING SENSOR DATA
Ethan A. Scarl *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 213-220 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

For practical automated diagnostic systems to continue functioning after failure, they must not only be able to diagnose sensor failures but also be able to tolerate the absence of data from the faulty sensors. It is shown that conventional (associational) diagnostic methods will have combinatoric problems when trying to isolate faulty sensors, even if they adequately diagnose other components. Moreover, attempts to extend the operation of diagnostic capability past sensor failure will necessarily compound those difficulties. Model-based reasoning offers a structured alternative that has no special problems diagnosing faulty sensors and can operate gracefully when sensor data is missing. Author

N89-26597*# Maryland Univ., College Park. Computer Vision Lab.
ROBOT ACTING ON MOVING BODIES (RAMBO): PRELIMINARY RESULTS
Larry S. Davis, Daniel DeMenthon, Thor Bestul, Sotirios Ziavras, H. V. Srinivasan, Madju Siddalingaiah, and David Harwood *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 223-236 (For primary document see N89-26578 20-63)
(Contract DACA76-88-C-0008)
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A robot system called RAMBO is being developed. It is equipped with a camera, which, given a sequence of simple tasks, can perform these tasks on a moving object. RAMBO is given a complete geometric model of the object. A low level vision module extracts and groups characteristic features in images of the object. The positions of the object are determined in a sequence of images, and a motion estimate of the object is obtained. This motion estimate is used to plan trajectories of the robot tool to relative locations nearby the object sufficient for achieving the tasks. More specifically, low level vision uses parallel algorithms for image enchancement by symmetric nearest neighbor filtering, edge detection by local gradient operators, and corner extraction by sector filtering. The object pose estimation is a Hough transform method accumulating position hypotheses obtained by matching triples of image features (corners) to triples of model features. To maximize computing speed, the estimate of the position in space of a triple of features is obtained by decomposing its perspective view into a product of rotations and a scaled orthographic projection. This allows the use of 2-D lookup tables at each stage of the decomposition. The position hypotheses for each possible match of model feature triples and image feature triples are calculated in parallel. Trajectory planning combines heuristic and dynamic programming techniques. Then trajectories are created using parametric cubic splines between initial and goal trajectories. All the parallel algorithms run on a Connection Machine CM-2 with 16K processors. Author

N89-26598*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DEVELOPMENT OF AN INTELLIGENT INTERFACE FOR ADDING SPATIAL OBJECTS TO A KNOWLEDGE-BASED GEOGRAPHIC INFORMATION SYSTEM
William J. Campbell and Craig Goettsche *In its* The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 239-247 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

Earth Scientists lack adequate tools for quantifying complex relationships between existing data layers and studying and modeling the dynamic interactions of these data layers. There is a need for an earth systems tool to manipulate multi-layered, heterogeneous data sets that are spatially indexed, such as sensor imagery and maps, easily and intelligently in a single system. The system can access and manipulate data from multiple sensor sources, maps, and from a learned object hierarchy using an advanced knowledge-based geographical information system. A prototype Knowledge-Based Geographic Information System (KBGIS) was recently constructed. Many of the system internals are well developed, but the system lacks an adequate user interface. A methodology is described for developing an intelligent user interface and extending KBGIS to interconnect with existing NASA systems, such as imagery from the Land Analysis System (LAS), atmospheric data in Common Data Format (CDF), and visualization of complex data with the National Space Science Data Center Graphics System. This would allow NASA to quickly explore the utility of such a system, given the ability to transfer data in and out of KBGIS easily. The use and maintenance of the object hierarchies as polymorphic data types brings, to data management, a while new set of problems and issues, few of which have been explored above the prototype level. Author

N89-26599*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
THE UTILIZATION OF NEURAL NETS IN POPULATING AN OBJECT-ORIENTED DATABASE
William J. Campbell, Scott E. Hill, and Robert F. Cromp *In its* The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 249-263 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

Existing NASA supported scientific data bases are usually developed, managed and populated in a tedious, error prone and self-limiting way in terms of what can be described in a relational Data Base Management System (DBMS). The next generation Earth remote sensing platforms (i.e., Earth Observation System, (EOS), will be capable of generating data at a rate of over 300 Mbs per second from a suite of instruments designed for different applications. What is needed is an innovative approach that creates object-oriented databases that segment, characterize, catalog and are manageable in a domain-specific context and whose contents are available interactively and in near-real-time to the user community. Described here is work in progress that utilizes an artificial neural net approach to characterize satellite imagery of undefined objects into high-level data objects. The characterized data is then dynamically allocated to an object-oriented data base where it can be reviewed and assessed by a user. The definition,

development, and evolution of the overall data system model are steps in the creation of an application-driven knowledge-based scientific information system. Author

N89-26600*# Martin Marietta Corp., Denver, CO. Information and Communications Systems.

A RAPID PROTOTYPING/ARTIFICIAL INTELLIGENCE APPROACH TO SPACE STATION-ERA INFORMATION MANAGEMENT AND ACCESS

Richard S. Carnahan, Jr., Stephen M. Corey, and John B. Snow *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 265-279 (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

Applications of rapid prototyping and Artificial Intelligence techniques to problems associated with Space Station-era information management systems are described. In particular, the work is centered on issues related to: (1) intelligent man-machine interfaces applied to scientific data user support, and (2) the requirement that intelligent information management systems (IIMS) be able to efficiently process metadata updates concerning types of data handled. The advanced IIMS represents functional capabilities driven almost entirely by the needs of potential users. Space Station-era scientific data projected to be generated is likely to be significantly greater than data currently processed and analyzed. Information about scientific data must be presented clearly, concisely, and with support features to allow users at all levels of expertise efficient and cost-effective data access. Additionally, mechanisms for allowing more efficient IIMS metadata update processes must be addressed. The work reported covers the following IIMS design aspects: IIMS data and metadata modeling, including the automatic updating of IIMS-contained metadata, IIMS user-system interface considerations, including significant problems associated with remote access, user profiles, and on-line tutorial capabilities, and development of an IIMS query and browse facility, including the capability to deal with spatial information. A working prototype has been developed and is being enhanced. Author

N89-26601*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

AN INTELLIGENT USER INTERFACE FOR BROWSING SATELLITE DATA CATALOGS

Robert F. Cromp and Sharon Crook *In its* The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 281-299 (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

A large scale domain-independent spatial data management expert system that serves as a front-end to databases containing spatial data is described. This system is unique for two reasons. First, it uses spatial search techniques to generate a list of all the primary keys that fall within a user's spatial constraints prior to invoking the database management system, thus substantially decreasing the amount of time required to answer a user's query. Second, a domain-independent query expert system uses a domain-specific rule base to preprocess the user's English query, effectively mapping a broad class of queries into a smaller subset that can be handled by a commercial natural language processing system. The methods used by the spatial search module and the query expert system are explained, and the system architecture for the spatial data management expert system is described. The system is applied to data from the International Ultraviolet Explorer (IUE) satellite, and results are given. Author

N89-26602*# Boeing Aerospace Co., Seattle, WA. Advanced Technology Center.

NATURAL LANGUAGE PROCESSING AND ADVANCED INFORMATION MANAGEMENT

James E. Hoard *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 301-315 (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

Integrating diverse information sources and application software in a principled and general manner will require a very capable advanced information management (AIM) system. In particular, such a system will need a comprehensive addressing scheme to locate the material in its docuverse. It will also need a natural language processing (NLP) system of great sophistication. It seems that the NLP system must serve three functions. First, it provides an natural language interface (NLI) for the users. Second, it serves as the core component that understands and makes use of the real-world interpretations (RWIs) contained in the docuverse. Third, it enables the reasoning specialists (RSs) to arrive at conclusions that can be transformed into procedures that will satisfy the users' requests. The best candidate for an intelligent agent that can satisfactorily make use of RSs and transform documents (TDs) appears to be an object oriented data base (OODB). OODBs have, apparently, an inherent capacity to use the large numbers of RSs and TDs that will be required by an AIM system and an inherent capacity to use them in an effective way. Author

N89-26603*# George Washington Univ., Washington, DC. Inst. for Artificial Intelligence.

INTEGRATION OF PERCEPTION AND REASONING IN FAST NEURAL MODULES

David G. Fritz *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 349-356 Prepared in cooperation with Cognitive Information Systems Co., Silver Spring, MD (For primary document see N89-26578 20-63)

Avail: NTIS HC A17/MF A01 CSCL 09B

Artificial neural systems promise to integrate symbolic and sub-symbolic processing to achieve real time control of physical systems. Two potential alternatives exist. In one, neural nets can be used to front-end expert systems. The expert systems, in turn, are developed with varying degrees of parallelism, including their implementation in neural nets. In the other, rule-based reasoning and sensor data can be integrated within a single hybrid neural system. The hybrid system reacts as a unit to provide decisions (problem solutions) based on the simultaneous evaluation of data and rules. Discussed here is a model hybrid system based on the fuzzy cognitive map (FCM). The operation of the model is illustrated with the control of a hypothetical satellite that intelligently alters its attitude in space in response to an intersecting micrometeorite shower. Author

N89-26604*# Maryland Univ., College Park. Dept. of Computer Science.

A CONNECTIONIST MODEL FOR DYNAMIC CONTROL

Kevin C. Whitfield, Sharon M. Goodall, and James A. Reggia *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 357-370 (For primary document see N89-26578 20-63)

(Grants NAG1-885; NSF IRI-84-51430)

Avail: NTIS HC A17/MF A01 CSCL 09B

The application of a connectionist modeling method known as competition-based spreading activation to a camera tracking task is described. The potential is explored for automation of control and planning applications using connectionist technology. The emphasis is on applications suitable for use in the NASA Space Station and in related space activities. The results are quite general and could be applicable to control systems in general. Author

N89-26605*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

EXPERT SYSTEM DEVELOPMENT METHODOLOGY AND THE TRANSITION FROM PROTOTYPING TO OPERATIONS: FIESTA, A CASE STUDY

Nadine Happell, Steve Miksell (Stanford Telecommunications, Inc., Reston, VA.), and Candace Carlisle *In its* The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr.

1989 p 373-383 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

A major barrier in taking expert systems from prototype to operational status involves instilling end user confidence in the operational system. The software of different life cycle models is examined and the advantages and disadvantages of each when applied to expert system development are explored. The Fault Isolation Expert System for Tracking and data relay satellite system Applications (FIESTA) is presented as a case study of development of an expert system. The end user confidence necessary for operational use of this system is accentuated by the fact that it will handle real-time data in a secure environment, allowing little tolerance for errors. How FIESTA is dealing with transition problems as it moves from an off-line standalone prototype to an on-line real-time system is discussed. Author

N89-26606*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
APPLICATIONS OF FUZZY SETS TO RULE-BASED EXPERT SYSTEM DEVELOPMENT c64
Robert N. Lea *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 385-388 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 12A

Problems of implementing rule-based expert systems using fuzzy sets are considered. A fuzzy logic software development shell is used that allows inclusion of both crisp and fuzzy rules in decision making and process control problems. Results are given that compare this type of expert system to a human expert in some specific applications. Advantages and disadvantages of such systems are discussed. Author

N89-26607*# Space Telescope Science Inst., Baltimore, MD.
GENETIC ALGORITHMS APPLIED TO THE SCHEDULING OF THE HUBBLE SPACE TELESCOPE c61
Jeffrey L. Sponsler *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 391-402 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 09B

A prototype system employing a genetic algorithm (GA) has been developed to support the scheduling of the Hubble Space Telescope. A non-standard knowledge structure is used and appropriate genetic operators have been created. Several different crossover styles (random point selection, evolving points, and smart point selection) are tested and the best GA is compared with a neural network (NN) based optimizer. The smart crossover operator produces the best results and the GA system is able to evolve complete schedules using it. The GA is not as time-efficient as the NN system and the NN solutions tend to be better. Author

N89-26608# Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
A NETWORK APPROACH TO FORCE CONTROL IN ROBOTICS AND TELEOPERATION Ph.D. Thesis
Robert John Anderson Jan. 1989 174 p
(Grant NSF DMC-85-16091)
(PB89-165476; DC-109; UILU-ENG-89-2205) Avail: NTIS HC A08/MF A01 CSCL 09B

The application of network theory to problems in robot and teleoperator control is studied. Network models, referred to as Hilbert networks, are developed which extend the definition of standard electrical circuit elements, operating over R, to high dimensional spaces. First, Hilbert networks are used to represent manipulators. Hilbert networks are next used to derive realistic models for the environment, including effects of contact/noncontact, coulomb friction, and nonlinear springs. Using the Hilbert network approach, passive and nonpassive controller architectures are studied in detail. The application of Hilbert networks to teleoperators results in the solution of a 20-year old problem, namely the time-delay instability problem in bilateral teleoperation. By mimicking the behavior of a passive transmission line, a control law is derived which globally stabilizes a teleoperator with force reflection, independent of the time delay in transmission of contact forces between the master and the slave. This result is proved theoretically, and verified experimentally. GRA

N89-26609# National Inst. of Standards and Technology, Gaithersburg, MD. Center for Manufacturing Engineering.
ARTIFICIAL INTELLIGENCE TECHNIQUES IN REAL-TIME PRODUCTION SCHEDULING
Wayne J. Davis (Illinois Univ., Urbana.) and Albert T. Jones Feb. 1989 20 p
(PB89-172571; NISTIR-88/3891) Avail: NTIS HC A03/MF A01 CSCL 09B

The real-time production scheduling problem is addressed as a special case of a much larger class of real-time decision-making/control problems. The definition of the scheduling problem is first reviewed and then an earlier algorithm proposed by the authors to address this problem is reviewed. It then concentrates on the possible application of various AI techniques to many of the functions that make up that algorithm. GRA

N89-26610*# Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.
NONLINEAR AND ADAPTIVE CONTROL Final Report, 1 Jun. 1984 - 31 Jan. 1989
Michael Athans Jul. 1989 24 p
(Grant NAG2-297)
(NASA-CR-180088; NAS 1.26:180088; LIDS-FR-1891; MIT-OSP-95178) Avail: NTIS HC A03/MF A01 CSCL 09B

The primary thrust of the research was to conduct fundamental research in the theories and methodologies for designing complex high-performance multivariable feedback control systems; and to conduct feasibiltiy studies in application areas of interest to NASA sponsors that point out advantages and shortcomings of available control system design methodologies. Author

N89-26611# Honeywell, Inc., Minneapolis, MN.
STRUCTURAL LIMITATIONS OF MODEL REFERENCE ADAPTIVE CONTROLLERS Interim Report, Sep. 1986 - Sep. 1988
James M. Krause and Gunter Stein Apr. 1989 9 p Previously announced in IAA as A88-27314
(Contract F08635-86-C-0138)
(AD-A206759; AFATL-TP-89-06) Avail: NTIS HC A02/MF A01 CSCL 12/2

A general framework is developed for the analysis of performance and robustness properties of tuned adaptive control systems. The analysis is specialized to the case of Model Reference Adaptive control. It is shown that certain combinations of performance objectives and a priori uncertainty lead to unsolvable MRAC design problems, while other combinations lead to problems which can be solved only by careful choice of the reference model. GRA

N89-26612# Honeywell, Inc., Minneapolis, MN. Systems and Research Center.
A GENERAL ADAPTIVE CONTROL STRUCTURE Technical Report, Sep. 1986 - Sep. 1988
James M. Krause and Gunter Stein 7 Dec. 1988 9 p
(Contract F08635-86-C-0138; AF Proj. 2304)
(AD-A206761; AFATL-TR-89-07) Avail: NTIS HC A02/MF A01 CSCL 12/2

A general adaptive control structure is given which provides flexibility in defining the plant and controller parameterizations and the goal of adaptation. A special case is conventional model reference adaptive control with independent uncertainty in all of the plant transfer function coefficients, although a much broader class of systems can be represented. A single derivation of the error equations for parameter estimation purpose is provided and is valid for the entire class of systems. GRA

N89-26613# Georgia Inst. of Tech., Atlanta. School of Information and Computer Science.
PARAMETRIC ANALYSIS OF QUEUEING NETWORKS WITH BLOCKING Final Report, 1 Nov. 1987 - 1 Nov. 1988
I. F. Akyildiz 1 Nov. 1988 10 p
(Grant AF-AFOSR-0028-88; DA Proj. 2304)
(AD-A206840; AFOSR-89-0424TR) Avail: NTIS HC A02/MF A01 CSCL 12/7

As we already observed in the investigation of queueing networks with blocking that the throughout is a non-decreasing function of the number of jobs (3), i.e., the blocking events have the effect of violating the throughout results. Two questions arose from this observation: (1) How to distribute the total buffer capacity to the stations such that no deadlock will occur and a maximum (optional) throughout will be achieved; and (2) Given the buffer capacity of each station in the network. How to select the total number of jobs in the network such that the throughput will be maximum (optimum). To answer these questions first we assumed that all stations have infinite capacity and derived new formulas for optimal throughput and response times based on the well-known mean value analysis approach (4). Then in (5) we found necessary and sufficient conditions for buffer allocation in the cyclic networks with blocking such that an optimal throughput will be achieved. GRA

N89-26614# Space Technology Corp., Fort Collins, CO.
ARCHITECTURAL STUDY OF ADAPTIVE ALGORITHMS FOR ADAPTIVE BEAM COMMUNICATION ANTENNAS Final Technical Report, Jul. 1985 - Jan. 1986
Michael Andrews and Robert E. Boring Jul. 1988 4 p
(Contract F19628-85-C-0144)
(AD-A206912; RADC-TR-88-137) Avail: NTIS HC A02/MF A01 CSCL 20/14

A comparative architecture study was performed in order to implement the scaled Given rotation solution to the least-squares minimization problem. Three architectures are examined: (1) Conventional Systolic Array, (2) SBNR Systolic Array, and (3) Distributed Arithmetic Systolic Array. Important considerations in adaptive beamforming algorithm to architecture mapping are also considered. The issues addressed included oversized array processing on fixed sized systolic arrays, error analysis, and design tools. GRA

N89-26615# Technische Univ., Eindhoven (Netherlands). Digital Systems Group.
A FORMALISM TO DESCRIBE CONCURRENT NONDETERMINISTIC SYSTEMS AND AN APPLICATION OF IT BY ANALYZING SYSTEMS FOR DANGER OF DEADLOCK
R. J. HuisintVeld Aug. 1988 50 p
(EUT-88-E-200; ISBN-90-6144-200-1; ISSN-0167-9708; ETN-89-94788) Avail: NTIS HC A03/MF A01

A formalism is introduced to describe the behavior of systems built out of concurrently running mechanisms. The central notion in this formalism is called process. It is used to specify the behavior of these systems. Criteria to differentiate between specifications are discussed. Each of these criteria is formalized by an equivalence relation on processes. The formalism is used to analyze the behavior of systems for deadlock-like properties. Several concepts describing these properties are introduced. It appears that a system may show one of these properties, while its components do not. For this purpose, theorems are derived. They state the conditions under which larger systems may be built out of smaller ones, without introducing deadlock-like properties. ESA

N89-26616# Technische Univ., Eindhoven (Netherlands). Measurement and Control Group.
A NOTATION CONVENTION IN RIGID ROBOT MODELLING
F. H. R. Lucassen (Lintronics B.V., Veghel, Netherlands) and H. H. vandeVen Oct. 1988 18 p
(EUT-88-E-208; ISBN-90-6144-208-7; ISSN-0167-9708; ETN-89-94796) Avail: NTIS HC A03/MF A01

A consistent notation, which covers all the relevant variables, for use in modeling the dynamic behavior of a rigid robot using only general theorems of dynamics and Newton Euler equations, is presented. ESA

N89-26617# Technische Univ., Eindhoven (Netherlands). Measurement and Control Group.
OPTIMAL BODY FIXED COORDINATE SYSTEMS IN NEWTON/EULER MODELLING
F. H. R. Lucassen (Lintronics B.V., Veghel, Netherlands) and H. H. vandeVen Nov. 1988 21 p
(EUT-88-E-210; ISBN-90-6144-210-9; ISSN-0167-9708; ETN-89-94798) Avail: NTIS HC A03/MF A01

Newton/Euler modeling of multibody mechanical systems considered to be an open kinematic chain consisting of n arbitrary bodies without branching is treated. In every link a so-called body fixed cartesian coordinate system is introduced. In real time applications the number of multiplications necessary for the computation of the transition matrices is of major importance. An optimal body fixed coordinate system with respect to the number of multiplications is derived. Starting with the collection of all possible body fixed coordinate systems and their corresponding transition matrices, the number of multiplications necessary for the computation of the transition matrices is counted. Several possible coordinate systems are considered and it is proved that for real time applications the Denavit-Hartenburg convention is the optimal choice. It contains only four multiplications. ESA

N89-26618# Oxford Univ. (England). Dept. of Engineering Science.
IMPROVED FORMULAE FOR THE 2-BLOCK H(SUP INFINITY) SUPER-OPTIMAL SOLUTION
D.-W. Gu, M. C. Tsai, and I. Postlethwaite 1988 14 p
(OUEL-1739/88; ETN-89-94818) Avail: NTIS HC A03/MF A01

Improved formulae for the algorithm given by Gu et al. (1989) are presented. The formulae are surprisingly neat and explicit. The strengthened H infinity minimization problem is described. It is shown that the basic minimization problem is equivalent to solving a model matching problem (Francis, 1987; Doyle, 1984). ESA

N89-26619# Oxford Univ. (England). VLSI Research Group.
A WSI FAULT-TOLERANT SEMANTIC NETWORK ARCHITECTURE
Jose G. Delgado-Frias and Will R. Moore Dec. 1988 36 p
(OUEL-1749/88; ETN-89-94819) Avail: NTIS HC A03/MF A01

A wafer scale computer architecture for semantic network processing is described. The application of such an architecture is computer vision scene labelling. The two dimensional array architecture may have a number of faulty processing elements. The knowledge base, which is represented as a semantic network, is mapped onto this irregular array. The mapping approach and the robustness of the semantic algorithm allow the machine to execute inferences despite physical faults. ESA

N89-26620# Technische Univ., Eindhoven (Netherlands).
ON RESIDUAL-BASED PARAMETERIZATION AND IDENTIFICATION OF MULTIVARIABLE SYSTEMS Ph.D. Thesis
Paulus Mathieu Josep VandenHof 1989 200 p
(ISBN-90-9002-659-2; ETN-89-94877) Avail: NTIS HC A09/MF A01

The problem of system identification is considered as a problem of deterministic approximate modeling on the basis of measurement data. In relation with classical methods of system identification, the approach presented shows two important aspects: the models obtained are accepted to be only an approximation of the dynamical process, underlying the data; and in the methodology of constructing models from the available time series, no use is made of any statistical assumptions on the data. Models for identification are defined in terms of behaviors, i.e., spaces of admissible signal trajectories. This notion of model behavior appears to present a unifying approach to all existing definitions of linear, time invariant and finite dimensional systems, such as transfer functions, state space representations, and different equations. It gives the

opportunity to clearly distinguish model sets from parameterizations, and to clearly distinguish the problems of identification and parameterization. ESA

N89-26621# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
RECONSTRUCTION AND REDUCTION OF CONTROL KNOWLEDGE. PART 3: RECONSTRUCTION FROM FINITE SAMPLES
C. Witteveen 1988 26 p
(Rept-88-72-Pt-3; ISSN-0922-5641; ETN-89-94903) Copyright Avail: NTIS HC A03/MF A01

A characterization of the internal structure of a Programmed Rule System (PRS) given some finite, incomplete description of its external behavior is considered, thus solving the so-called control identification problem for PRS's. To identify the PRS from such finite sample information, the sample has to satisfy a structural completeness property (context-completeness). It is showm that a context-complete sample fully characterizes the complete external behavior and can be used to construct the PRS generating this behavior. The relationship between constructive approaches for specific types of control constructs and more general approaches using enumerative approaches is discussed. A proposal is made for introducing defaults as defeasible assumptions into inductive inference theory. ESA

N89-26622# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abteilung fuer Systemtechnik und Navigation.
KNOWLEDGE-BASED FAULT DETECTION AND DIAGNOSIS FOR ROBOTS: FIRST RESULTS FOR THE ROTEX ROBOT
Hans-Juergen Hotop and Claus-Dieter Strube Jan. 1989 51 p In GERMAN; ENGLISH summary
(DFVLR-FB-89-03; ISSN-0171-1342; ETN-89-94979) Avail: NTIS HC A04/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 18.50

The concept of self-detection for robots in space is presented for the fault detection and diagnosis system of the robot in the D2-Spacelab mission. The robot experiment is described as well as the parts for the health and fault management which are developed in conventional techniques and with methods of artificial intelligence. The hardware and software and the implementation of the expert system for the power detection are outlined. ESA

N89-26623*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED STRUCTURE/CONTROL LAW DESIGN BY MULTILEVEL OPTIMIZATION
Michael G. Gilbert and David K. Schmidt Jun. 1989 12 p Presented at the AIAA Guidance, Navigation and Control Conference, Boston, MA, 14-16 Aug. 1989
(NASA-TM-101623; NAS 1.15:101623) Avail: NTIS HC A03/MF A01 CSCL 09B

A new approach to integrated structure/control law design based on multilevel optimization is presented. This new approach is applicable to aircraft and spacecraft and allows for the independent design of the structure and control law. Integration of the designs is achieved through use of an upper level coordination problem formulation within the multilevel optimization framework. The method requires the use of structure and control law design sensitivity information. A general multilevel structure/control law design problem formulation is given, and the use of Linear Quadratic Gaussian (LQG) control law design and design sensitivity methods within the formulation is illustrated. Results of three simple integrated structure/control law design examples are presented. These results show the capability of structure and control law design tradeoffs to improve controlled system performance within the multilevel approach. Author

64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

N89-26624*# California Univ., San Diego.
VECTOR FIELDS AND NILPOTENT LIE ALGEBRAS
Matthew Grayson and Robert Grossman (Illinois Univ., Chicago.) [1987] 20 p
(Grant NAG2-513)
(NASA-CR-184967; NAS 1.26:184967) Avail: NTIS HC A03/MF A01 CSCL 12A

An infinite-dimensional family of flows E is described with the property that the associated dynamical system: $x(t) = E(x(t))$, where $x(0)$ is a member of the set R to the Nth power, is explicitly integrable in closed form. These flows E are of the form $E = E1 + E2$, where E1 and E2 are the generators of a nilpotent Lie algebra, which is either free, or satisfies some relations at a point. These flows can then be used to approximate the flows of more general types of dynamical systems. Author

N89-26625*# California Univ., Berkeley.
COMPUTER ALGEBRA AND OPERATORS
Richard Fateman and Robert Grossman (Illinois Univ., Chicago.) Jan. 1989 14 p Prepared in cooperation with International Business Machines Corp., Armonk, NY
(Contract NAG2-513; N00039-84-C-0089; NSF CCR-88-12843; DARPA Order 4871)
(NASA-CR-185396; NAS 1.26:185396) Avail: NTIS HC A03/MF A01 CSCL 12A

The symbolic computation of operator expansions is discussed. Some of the capabilities that prove useful when performing computer algebra computations involving operators are considered. These capabilities may be broadly divided into three areas: the algebraic manipulation of expressions from the algebra generated by operators; the algebraic manipulation of the actions of the operators upon other mathematical objects; and the development of appropriate normal forms and simplification algorithms for operators and their actions. Brief descriptions are given of the computer algebra computations that arise when working with various operators and their actions. K.C.D.

N89-26626*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
BIDIAGONALIZATION AND SYMMETRIC TRIDIAGONALIZATION BY SYSTOLIC ARRAYS
Robert Schreiber (Rensselaer Polytechnic Inst., Troy, NY.) Oct. 1988 19 p Submitted for publication
(Contracts NCC2-387; N00014-86-K-0610)
(NASA-CR-185415; NAS 1.26:185415; RIACS-TR-88.30) Avail: NTIS HC A03/MF A01 CSCL 12A

A systolic algorithm and an array for bidiagonalization of an nxn matrix in O(nlog(2)n) time, using O(n to the 2nd power) cells are given. Bandedness of the input matrix may be effectively exploited. If the matrix is banded, with p nonzero subdiagonals and q nonzero superdiagonals, then $4n\ln(p + q) + O(n)$ clocks and $2n(p + q) + O((p + q)$ to the 2nd power $+ n)$ cells are needed. This is faster than the best previously reported result by the factor $\log(2)e = 1.44...$. Moreover, in contrast to earlier systolic designs, which require the matrix to be preloaded into the array and the result matrix extracted after bidiagonalization, the present arrays are pipelined. Author

N89-26627*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
PARALLEL MATRIX MULTIPLICATION ON THE CONNECTION MACHINE
Walter F. Tichy (Karlsruhe Univ., Germany, F.R.) Nov. 1988 42 p Submitted for publication
(Contract NCC2-387)
(NASA-CR-185423; NAS 1.26:185423; RIACS-TR-88.41) Avail: NTIS HC A03/MF A01 CSCL 12A

Matrix multiplication is a computation and communication intensive problem. Six parallel algorithms for matrix multiplication

on the Connection Machine are presented and compared with respect to their performance and processor usage. For n by n matrices, the algorithms have theoretical running times of O(n to the 2nd power log n), O(n log n), O(n), and O(log n), and require n, n to the 2nd power, n to the 2nd power, and n to the 3rd power processors, respectively. With careful attention to communication patterns, the theoretically predicted runtimes can indeed be achieved in practice. The parallel algorithms illustrate the tradeoffs between performance, communication cost, and processor usage. Author

N89-26628*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
SOME SPECTRAL APPROXIMATION OF ONE-DIMENSIONAL FOURTH-ORDER PROBLEMS Final Report
Christine Bernardi and Yvon Maday (Paris VII Univ., France) Jun. 1989 79 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-181856; ICASE-89-36; NAS 1.26:181856) Avail: NTIS HC A05/MF A01 CSCL 12A

Some spectral type collocation method well suited for the approximation of fourth-order systems are proposed. The model problem is the biharmonic equation, in one and two dimensions when the boundary conditions are periodic in one direction. It is proved that the standard Gauss-Lobatto nodes are not the best choice for the collocation points. Then, a new set of nodes related to some generalized Gauss type quadrature formulas is proposed. Also provided is a complete analysis of these formulas including some new issues about the asymptotic behavior of the weights and we apply these results to the analysis of the collocation method. Author

N89-26629*# National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.
CALIBRATION OF A PHOTOMULTIPLIER ARRAY SPECTROMETER
Steven A. Bailey, C. Wayne Wright, and Charles R. Piazza Jun. 1989 8 p
(NASA-TM-100739; NAS 1.15:100739) Avail: NTIS HC A02/MF A01 CSCL 12A

A systematic approach to the calibration of a photomultiplier array spectrometer is presented. Through this approach, incident light radiance derivation is made by recognizing and tracing gain characteristics for each photomultiplier tube. Author

N89-26630# Mitre Corp., Bedford, MA.
ALGEBRAIC INTEGER QUANTIZATION AND CONVERSION Final Report, Oct. 1986 - Oct. 1987
Richard A. Games, Sean D. ONeil, and Joseph J. Rushanan Jul. 1988 134 p
(Contract F19628-86-C-0001)
(AD-A206664; MTR-10337; RADC-TR-88-167) Avail: NTIS HC A07/MF A01 CSCL 12/3

The algebraic-integer number representation, in which the signal sample is represented by a set of (typically four to eight) small integers, combines with Residue Number System (RNS) processing to produce processors composed of simple parallel channels. The analog samples must first be converted into the algebraic-integer representation, and the final algebraic-integer result converted back to an analog or digital form. These are quantization problems. Second, the algebraic-integer representation must be converted into and out of two levels of RNS parallelism. These are RNS conversion problems. This paper provides practical solutions, which can be implemented with current technology, to these quantization and conversion problems. GRA

N89-26631# Princeton Univ., NJ.
LUMPED MODEL GENERATION AND EVALUATION: SENSITIVITY AND LIE ALGEBRAIC TECHNIQUES WITH APPLICATIONS TO COMBUSTION Final Report
H. Rabitz, F. L. Dryer, and R. Yetter 3 Mar. 1989 10 p
(Grant AF-AFOSR-0346-85; AF Proj. 2308)
(AD-A206683; AFOSR-89-0418TR) Avail: NTIS HC A02/MF A01 CSCL 07/4

This program dealt with the development and application of new approaches for producing and evaluating semi-empirical (lumped parameter) models of physical processes. Procedures using local sensitivity gradient methods were used to study the existing lumped kinetic models for the moist carbon monoxide oxidation to show that transport processes can cause oversimplified lumped models derived from homogeneous kinetics to fail when applied to flame propagation systems. New models are under development which will include the appropriate level of detail. A Lie group formalism was developed to address global parameter space mapping issues for first order differential equations. The rigorous criteria for the existence of exact lumping by linear projective transformations was also established. GRA

N89-26632# California Univ., Berkeley. Center for Pure and Applied Mathematics.
ON THE FORWARD INSTABILITY OF THE QR TRANSFORMATION
J. Le and B. N. Parlett Jul. 1988 41 p
(Contract N00014-76-C-0013)
(AD-A206865; PAM-419) Avail: NTIS HC A03/MF A01 CSCL 12/1

This study is in the area of matrix eigenvalue computations The Householder-QR algorithm has become the standard method for diagonalizing a symmetric matrix. First the matrix is reduced to tridiagonal form T by a technique introduced by A. Householder in 1958. Next the tridiagonal matrix T is diagonalized by successive applications of the QR transformation with shifts. Moreover it is well known that the QR transformation is backward stable. That means that the computed transform is exactly orthogonally similar to a matrix close to the old one. It is also known to the experts that the QR transformation sometimes exhibits forward instability. That means the the computed output is far from the result obtained with exact arithmetic. For the purpose of computing eigenvalues and eigenvectors the property of backward stability is all that one requires. However the QR transformation has other uses and in some cases forward stability is desirable. This report analyzes the forward instability of QR and shows that it occurs only when the shift is very close to eigenvalues with a special property. GRA

N89-26633# Army Armament Research, Development and Engineering Center, Watervliet, NY.
SWITCHING ZONE CONTROL FOR A SYSTEM WITH AN ELASTIC JOINT Final Technical Report
Ronald L. Racicot and Sheldon S. L. Chang (State Univ. of New York, Stony Brook.) Mar. 1989 24 p
(AD-A206870; ARCCB-TR-89006) Avail: NTIS HC A03/MF A01 CSCL 12/9

An extension of the powerful Switching Zone Control (SZC) approach to include systems with elastic joints is presented. SZC is a decentralized non-linear feedback controller that approaches the minimum time bang-bang controller in the limit. The controller is robust and has a number of desirable attributes which are discussed in this report. The problems that are resolved in applying SZC to the flexible joint mechanism include stability, controller design, and nonzero steady-state disturbances. Simulation and experimental results demonstrate the usefulness of the developed procedures for practical applications. GRA

N89-26634# Boston Univ., MA. Center for Adaptive Systems.
SOLVING THE BRIGHTNESS-FROM-LUMINANCE PROBLEM: A NEURAL ARCHITECTURE FOR INVARIANT BRIGHTNESS PERCEPTION Interim Report
Stephen Grossberg and Dejan Todorovic Feb. 1989 39 p
(Contracts F49620-86-C-0037; F49620-87-C-0018)
(AD-A206890; AFOSR-89-0457TR) Avail: NTIS HC A03/MF A01 CSCL 12/9

The spatial distribution of light that constitutes the input to our eyes is the foundation of all visual functions, such as perception of brightness, color, texture, form, and 3-D organization. The perception of brightness may perhaps appear to be the simplest

of all functions: The most natural initial explanation of why surface A appears brighter than surface B is that more light arrives into our eyes from surface A than from B. However, as we will show in the following, the relation of luminance (which is a physical variable involving the amount of light energy arriving at the retina) and brightness (which is a psychological variable denoting perceived intensity of light) is much more complicated. The brightness-from luminance problem is the following: find the mapping that transforms any given spatial distribution of luminance into the corresponding spatial distribution of brightness. The problem is generally solved for the simple visual situation involving a bright patch on a dark background. Increasing the luminance of the patch causes it to look increasingly brighter, but in a nonlinear manner. In more complicated visual situations containing several surfaces, their brightnesses may be predicted by taking logarithms, or power functions, of their luminance. To summarize, there are at least two factors that make the relation of brightness and luminance a problem: Illumination discounting and contextual dependence. GRA

N89-26635# Brown Univ., Providence, RI. Div. of Applied Mathematics.
RESEARCH ON DETERMINISTIC AND STOCHASTIC PARTIAL DIFFERENTIAL EQUATIONS WITH APPLICATIONS TO CONTINUUM PHYSICS AND STOCHASTIC SYSTEMS MODELLING Final Technical Report, 1 Jul. 1983 - 30 Jun. 1988
Wendell H. Fleming 30 Jun. 1988 14 p
(Contract N00014-83-K-0542)
(AD-A206907) Avail: NTIS HC A03/MF A01 CSCL 12/1

This is a summary of research done by four senior investigators. Dafermos' research focused on a number of problems that lie at the interface of continuum mechanics and analysis. Fleming's research was concerned with optimal stochastic control theory, nonlinear filtering, large deviations for Markov diffusions, and viscosity solutions of nonlinear partial differential equations. Kushner's research covered a wide range of topics in stochastic systems theory and applied probability. Souganidis worked in the area of first and second order nonlinear partial differential equations, where a number of results concerning approximations with error estimates, singular perturbations and representation formulae were found. He also worked on questions of stability of special solutions of equation in fluids, as well as the structure of solutions of equations describing flows through porous media (implosion of waves). GRA

N89-26636# Texas Univ., Arlington. Computation Fluids Dynamics Center.
DEVELOPMENT OF ADAPTIVE GRID SCHEMES BASED ON POISSON GRID GENERATORS Final Report, 15 May 1985 - 14 Nov. 1988
Dale A. Anderson Jan. 1989 60 p
(Grant AF-AFOSR-0195-85; AF Proj. 2307)
(AD-A206922; UTA-CFD-89-02; AFOSR-89-0217TR) Avail: NTIS HC A04/MF A01 CSCL 20/4

Poisson equation grid generators are the most popular differential equation mesh generation schemes. Results reported under this program show how to use the existing schemes to construct adaptive grids. Methods for controlling individual arc lengths as well as cell volumes are given and technique for constructing two-dimensional orthogonal adaptive grids are included. Adaptivity was also demonstrated with unstructured meshes using the Poisson equation as a control on grid point location. Additional adaption schemes for unstructured grids presented using a linear spring analogy. GRA

N89-26637# Wisconsin Univ., Madison. Dept. of Computer Sciences.
NUMERICAL ANALYSIS Annual Report, 15 Jun. 1987 - 14 Jun. 1988
Syemour V. Parter 1989 6 p
(Grant AF-AFOSR-0163-86; AF Proj. 2304)
(AD-A207000; AFOSR-89-0378TR) Avail: NTIS HC A02/MF A01 CSCL 12/1

Work has continued during this period on the following projects: (1) The role of regularity in Multigrid methods (computational experiments and analytical studies on the V-cycle in an L-shaped domain); (2) Preconditioning and boundary values (study of preconditioning of elliptic operators); and (3) Preconditioning, boundary values and mixed mode (extension of (2) above to hyperbolic operators). GRA

N89-26638# State Univ. of New York, Albany. Research Foundation.
QUALITATIVE RESULTS FOR DISTRIBUTED SYSTEMS Final Scientific Report, 1 Jul. 1985 - 30 Jun. 1988
Daniel J. Inman 4 Oct. 1988 10 p
(Grant AF-AFOSR-0220-85; AF Proj. 2304)
(AD-A207005; AFOSR-89-0426TR) Avail: NTIS HC A02/MF A01 CSCL 12/4

This document summarizes the research accomplished under the support of AFOSR-85-0220 from the period of July 1, 1985 to June 30, 1988. Results obtained during this period under AFOSR support are briefly described in the first section. This section is followed by listings of books published, papers published, proceedings published, degrees granted and lectures given while the PI was under Air Force Support. Several results were obtained under the support of this grant which related to the distributed parameter, or partial differential equation, model of a flexible structure. The global model forming the thrust of this research is given by a set of partial differential equations defined on some domain omega with the appropriate boundary and initial conditions. GRA

N89-26639*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
NUMERICAL SOLUTION OF LARGE NONSYMMETRIC EIGENVALUE PROBLEMS
Youcef Saad Nov. 1988 33 p
(Contract NCC2-387)
(NASA-CR-185062; NAS 1.26:185062; RIACS-TR-88.39) Avail: NTIS HC A03/MF A01 CSCL 12A

Several methods are discribed for combinations of Krylov subspace techniques, deflation procedures and preconditionings, for computing a small number of eigenvalues and eigenvectors or Schur vectors of large sparse matrices. The most effective techniques for solving realistic problems from applications are those methods based on some form of preconditioning and one of several Krylov subspace techniques, such as Arnoldi's method or Lanczos procedure. Two forms of preconditioning are considered: shift-and-invert and polynomial acceleration. The latter presents some advantages for parallel/vector processing but may be ineffective if eigenvalues inside the spectrum are sought. Some algorithmic details are provided that improve the reliability and effectiveness of these techniques. Author

N89-26640# Washington Univ., Seattle. Dept. of Statistics.
SIMPLE ROBUST FIXED LAG SMOOTHING Technical Report No. 149
N. D. Le and R. D. Martin 2 Dec. 1988 38 p
(Contract N00014-86-K-0819)
(AD-A207204) Avail: NTIS HC A03/MF A01 CSCL 12/3

A class of robust lag-l smoothers is introduced which are based on simple low order Markov models for the Gaussian trend-like component of signal plus non-Gaussian noise models. The kth order Markov models are of the Kth difference form Delta k x sub t = epsilon sub t where Delta x sub t = x sub t - x sub (t-1) and epsilon sub t is a zero-mean white Gaussian noise process with variance sigma sq sub epsilon. The nominal additive noise is a zero-mean white Gaussian noise sequence with variance sigma sq sub 0, while the actual additive noise is non-Gaussian with an outliers generating distribution, e.g., (1-gamma)N(0, sigma sq sub 0) + gamma H. This setup is particularly appropriate for radar glint noise. Implementation of the smoothers requires estimation of the two parameters sigma-sq sub epsilon and sigma-sub 0.

This is accomplished using a robustified maximum likelihood approach. Application to both artificial data sets and to glint noise data reveals that the approach is quite effective. The choice of lag-l for the smoothers is briefly discussed and the sensitivity of the approach to model mismatch briefly studied. GRA

N89-26641# Rome Univ. (Italy). Dipartimento di Fisica.
THE PERIODIC RELATIVISTIC TODA-LATTICE: DIRECT AND INVERSE PROBLEM
O. Ragnisco and M. Bruschi 1 Aug. 1988 26 p Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-615; ETN-89-94700) Avail: NTIS HC A03/MF A01

The direct and inverse spectral problem for the periodic relativistic Toda lattice is solved. The time evolution of the spectral variables can be calculated explicitly. A set of canonically conjugated variables is constructed, in terms of which the motion is completely separated. ESA

N89-26642# California Univ., Santa Cruz.
THE PRODUCT OF RANDOM MATRICES IN A MICROCANONICAL ENSEMBLE
J. M. Deutsch and Giovanni Paladin 21 Sep. 1988 11 p Submitted for publication Sponsored by NSF, Washington, DC Prepared in cooperation with Rome Univ., Italy
(Preprint-623; ETN-89-94704) Avail: NTIS HC A03/MF A01

An approximate formula for the Lyapunov exponent of the product of N independent random matrices Mk all distributed according to the same probability distribution is given. The case of a Bernoullian distribution is considered: Mk=A with probability p and Mk=B otherwise. The comparison with numerical calculations for matrices A and B related to localization in the one-dimensional Anderson model is discussed. The fluctuation spectrum for the Lyapunov exponent is given. ESA

N89-26643# Rome Univ. (Italy). Dipartimento di Fisica.
SOLUTIONS OF CERTAIN INTEGRABLE NONLINEAR PDEs DESCRIBING NONRESONANT N-WAVE INTERACTIONS
F. Calogero 23 Sep. 1988 24 p Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-624; ETN-89-94705) Avail: NTIS HC A03/MF A01

The standard equations that describe the nonresonant interaction of N dispersive waves are described and special cases which are integrable by quadratures are considered. The subclass of localized solutions gives rise to a solitonic phenomenology. The class of solutions that are asymptotically finite contains a richer solitonic phenomenology. The analysis is confined to 1+1 dimensions. Generalizations are also presented, including a partially solvable multidimensional extension. ESA

N89-26644# Rome Univ. (Italy). Dipartimento di Fisica.
LIE-ISOTROPIC GENERALIZATION OF BERRY'S PHASE
R. Mignani 28 Sep. 1988 6 p Presented at the 4th Workshop on Hadronic Mechanics and Non-Potential Interactions, Skopje, Yugoslavia, 21-24 Aug. 1988 Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy and Institute for Basic Research, Cambridge, MA
(Preprint-625; ETN-89-94706) Avail: NTIS HC A02/MF A01

The generalization is based on the adiabatic evolution of a quantum system, in the hypothesis that its internal forces are of non potential, non Hamiltonian type. The resulting Berry connection is in agreement with the Lie isotopic lifting of gauge theories. It is pointed out that experiments of Berry's phase by neutron interferometry may also be good tests of hadronic mechanics. ESA

N89-26645# Rome Univ. (Italy). Dipartimento di Fisica.
THE STOCHASTIC ACTION OF DYNAMICAL SYSTEMS ON CURVED MANIFOLDS. 1: THE GEODESIC INTERPOLATION
Ettore Aldrovandi, Daniela Dohrn (Salerno Univ., Italy), and Francesco Guerra 6 Oct. 1988 25 p Submitted for publication Sponsored in part by the Italian Ministry of Public Education Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-630; ETN-89-94710) Avail: NTIS HC A03/MF A01

Dynamical systems are studied with a Lagrangian at most quadratic in the velocity. The problem of extending the action functional from the smooth deterministic trajectories of classical mechanics to the very irregular random trajectories of diffusions in configuration space is considered. In this way the action becomes a functional of the trial diffusion processes and can be put at the basis of stochastic variational principles. It is shown that a change of the connection field is equivalent to a well defined renormalization of the scalar potential. ESA

N89-26646# Rome Univ. (Italy). Dipartimento di Fisica.
THE ANAMOLOUS CHIRAL SCHWINGER MODEL AND ITS QUANTIZATION: EIGENFUNCTIONALS AND ENERGY SPECTRUM
C. Pittori 10 Oct. 1988 32 p Submitted for publication
(Preprint-631; ETN-89-94711) Avail: NTIS HC A03/MF A01

The possibility of a gauge invariant quantization of anomalous chiral gauge theories in the context of two-dimensional Abelian models is treated. The method diagonalizes the Hamiltonian making use of functional techniques, instead of performing canonical transformations. In this way the explicit construction of the eigenfunctionals is carried out and the energy spectrum is analyzed. The eigenfunctionals of the system of left handed fermions interacting with gauge fields are discussed, as well as free right handed fermions, and their energy spectrum is presented. ESA

N89-26647# Rome Univ. (Italy). Dipartimento di Fisica.
ALGEBRAIC PROPERTIES AND SYMMETRIES OF INTEGRABLE EVOLUTION EQUATIONS
P. M. Santini 25 Oct. 1988 14 p Presented at the Symposium on Symmetries in Sciences 3, Austria, 25-28 Jul. 1988 Submitted for publication Prepared in cooperation with Istitutio Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-636; ETN-89-94716) Avail: NTIS HC A03/MF A01

The algebraic properties of nonlinear integrable systems are reviewed. Well known integrable systems are described including Korteweg de Vries, nonlinear Schroedinger, intermediate longwave, Chiral fields, and Davey Stewartson equations. Special emphasis is given to the fact that these equations are different realizations of the same operator structure and that they are essentially equivalents from an algebraic point of view. A theory developed by Fokas and Santini is discussed. It associates the recursion operators and the bi-Hamiltonian structures of integrable systems. Dimensional deformations are examined with the goal of generating integrable generalizations in higher dimensions. ESA

N89-26648# Rome Univ. (Italy). Dipartimento di Fisica.
SCALING THEORY OF SELF ORGANIZED CRITICALITY
Yi-Cheng Zhang 13 Jan. 1989 12 p Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-651; ETN-89-94725) Avail: NTIS HC A03/MF A01

The self organized critical phenomena of Bak, Tang, and Wiesenfeld is studied. A continuous energy model is introduced. The numerical simulations show that the energy is homogeneously and isotropically distributed and concentrated around discrete attractors. A scaling theory is proposed to estimate the various scaling exponents. ESA

N89-26649# Oxford Univ. (England). Dept. of Engineering Science.
THE EXACT ANALYSIS OF BARREL-VAULT GRID PROBLEMS
J. D. Renton 1989 11 p
(OUEL-1753/89; ETN-89-94821) Avail: NTIS HC A03/MF A01

Barrel vault grids are analyzed by examining equivalent shells whose properties are deduced on the basis of intuitive assumptions. The advantage is that a general solution to a particular problem can be obtained which is valid for a wide variety of grids. However, the same advantage can be obtained from an analysis using finite difference calculus. General finite difference equations are derived

for rectangular barrel vault grids and a particular solution is compared with that obtained using an equivalent shell analysis. ESA

N89-26650# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
THE CONTIGUOUS FUNCTION RELATIONS FOR THE BASIC HYPERGEOMETRIC SERIES
Rene F. Swarttouw 1988 21 p
(Rept-88-65; ISSN-0922-5641; ETN-89-94897) Copyright Avail: NTIS HC A03/MF A01

Contiguous relations for the q-extension of a generalized hypergeometric function are derived. An application to the little q-Jacobi polynomials is given. ESA

N89-26651# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
ESTIMATES FOR ELLIPTIC SINGULAR PERTURBATIONS IN Lp SPACES
G. Sweers 1988 79 p
(Rept-88-73; ISSN-0922-5641; ETN-89-94904) Copyright Avail: NTIS HC A05/MF A01

Two-sided a-priori estimates in L sub p-type for a class of singularly perturbed elliptic problems with Dirichlet boundary conditions are studied using Fourier multipliers. ESA

N89-26652# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
PHASE PORTRAITS FOR QUADRATIC SYSTEMS WITH A HIGHER ORDER SINGULARITY. PART 3: THIRD AND FOURTH ORDER POINTS WITH ONE ZERO EIGENVALUE
P. deJager 1988 43 p
(Rept-88-79-Pt-3; ISSN-0922-5641; ETN-89-94908) Copyright Avail: NTIS HC A03/MF A01

Quadratic systems with a fourth order saddle node; quadratic systems with a third order saddle point; and quadratic systems with a third order node are analyzed. ESA

N89-26653# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
A COMPARATIVE STUDY OF PRIMAL AND DUAL APPROACHES FOR SOLVING SEPARABLE AND PARTIALLY-SEPARABLE NONLINEAR OPTIMIZATION PROBLEMS
F. A. Lootsma 1988 18 p
(Rept-88-85; ISSN-0922-5641; ETN-89-94912) Copyright Avail: NTIS HC A03/MF A01

The problem of optimizing the dual objective function I over a non-negative orthant is considered. The evaluation of I reduces to the execution of independent linear searches only. To generalize the idea, partially-separable problems with objective and constraint functions such that the Hessian matrix of the Lagrange function is a block-diagonal matrix with 2*2 blocks are also considered. The evaluation of the dual objective function is accordingly reduced to a number of independent planar searches. The performance of a primal and a dual method is compared on a graded set of artificial test problems with increasing size, increasing degree of degeneracy, and increasing ill-conditioning. The observed speed-up by the dual approach varies between 2 and 30. The potential of the dual approach for execution on parallel computers is mentioned. ESA

N89-26654# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
KOORNWINDER'S GENERALIZED LAGUERRE POLYNOMIALS AND ITS q-ANALOG
Roelof Koekoek 1988 46 p
(Rept-88-87; ISSN-0922-5641; ETN-89-94913) Copyright Avail: NTIS HC A03/MF A01

Properties of polynomials which are generalizations of the classical Jacobi polynomials are discussed. Properties of the q-Laguerre polynomials described by Moak (1981) are summarized. A q-analog of the generalized Laguerre polynomials is described. These orthogonal polynomials are generalizations of the q-Laguerre polynomials. ESA

N89-26655# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
ON THE ZEROS OF A NEW CLASS OF ORTHOGONAL POLYNOMIALS
H. Bavinck and H. G. Meijer 1988 16 p
(Rept-88-95; ISSN-0922-5641; ETN-89-94915) Copyright Avail: NTIS HC A03/MF A01

For (S sub n) a set of orthogonal polynomials with respect to a symmetric inner product, it is provided that the zeros of S sub n are real and simple and that for n sufficiently large exactly one pair lies outside (-1,1). Moreover two five-term recurrence relations are given. ESA

N89-26656 National Physical Lab., Teddington (England). Div. of Information Technology and Computing.
POLYNOMIAL FITTING TO NOISY DATA WHERE SUBSETS OF THE DATA ARE SUBJECT TO UNKNOWN VERTICAL SHIFTS
Helen M. Anthony and P. M. Harris Dec. 1988 17 p
(ETN-89-94963) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW11 0LW, United Kingdom

It is shown how a polynomial may be fitted to noisy data, subsets of which are subject to unknown vertical shifts. The model used consists of a polynomial together with extra parameters representing the shifts. The polynomial coefficients and the shifts are determined by fitting the model to the data in the least squares sense. The method is applied to data arising from the measurement of the time taken for light of various wavelengths to propagate in a single mode optical fiber. The fit to this data is differentiated to provide an approximation to the dispersion for the optical fiber. ESA

N89-26657 Politecnico di Milano (Italy). Lab. di Calolatori.
DESIGN AND IMPLEMENTATION OF A VLSI SERIAL MULTIPLIER FOR FIXED POINT NUMBERS WITH SELF-CHECKING CAPABILITY
Luca Breveglieri 1988 11 p
(Rept-88-026; ETN-89-94970) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

A serial multiplication algorithm is discussed and implemented by means of a CMOS technology. The AN codes technique is used to allow self-checking of the device and is also implemented. Guidelines to design the test vectors for the device are presented. ESA

N89-26658 Politecnico di Milano (Italy). Dipt. di Elettronica.
THE LQG PROBLEM FOR MULTIRATE SAMPLED DATA SYSTEMS
P. Colaneri, R. Scattolini (Pavia Univ., Italy), and N. Schiavoni 1989 23 p Sponsored in part by the Italian Ministry of Public Education
(Rept-89-018; ETN-89-94972) Avail: Politecnico di Milano, Piazza Leonardo da Vinci 32, 20133 Milan, Italy

The LQG control problem is formulated and solved for multivariable systems where the output variables of the plant are measured at different rates. These rates can be definitively less than the unique one adopted for the inputs updating. It is shown how a suitable description both of the plant and of the skew sampling mechanism can be given in terms of a linear periodic system. The solution is worked out by solving a singular periodic prediction problem and by resorting to the separation principle. ESA

N89-26606*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
APPLICATIONS OF FUZZY SETS TO RULE-BASED EXPERT SYSTEM DEVELOPMENT
Robert N. Lea *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial

Intelligence Apr. 1989 p 385-388 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 12A

65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

N89-26659*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVALUATION OF FAULT-TOLERANT PARALLEL-PROCESSOR ARCHITECTURES OVER LONG SPACE MISSIONS
Sally C. Johnson Washington Aug. 1989 32 p
(NASA-TM-4123; L-16437; NAS 1.15:4123) Avail: NTIS HC A03/MF A01 CSCL 12A

The impact of a five year space mission environment on fault-tolerant parallel processor architectures is examined. The target application is a Strategic Defense Initiative (SDI) satellite requiring 256 parallel processors to provide the computation throughput. The reliability requirements are that the system still be operational after five years with .99 probability and that the probability of system failure during one-half hour of full operation be less than 10(-7). The fault tolerance features an architecture must possess to meet these reliability requirements are presented, many potential architectures are briefly evaluated, and one candidate architecture, the Charles Stark Draper Laboratory's Fault-Tolerant Parallel Processor (FTPP) is evaluated in detail. A methodology for designing a preliminary system configuration to meet the reliability and performance requirements of the mission is then presented and demonstrated by designing an FTPP configuration. Author

N89-26660# Illinois Univ., Urbana. Coordinated Science Lab.
STOCHASTIC SYSTEMS WITH MULTIPLE DECISION MAKERS AND PARAMETRIC UNCERTAINTIES Final Report, 1 May 1985 - 30 Apr. 1988
Tamer Basar 20 Jun. 1988 27 p
(Grant AF-AFOSR-0056-84; AF Proj. 2304)
(AD-A206655; AFOSR-89-0423TR) Avail: NTIS HC A03/MF A01 CSCL 12/4

This final report summarizes the findings of research on the topic Stochastic Dynamic Systems with Multiple Decision Makers and Parametric Uncertainties, supported by a Grant from the Air Force Office of Scientific Research, during the period May 1, 1985-April 30, 1988. The focus of the research during this three-year period has been on the development of methodologies and new solution techniques for obtaining strategies in stochastic systems, with good sensitivity properties, and for deriving optimal decision rules in systems with nonclassical information patterns. A further major thrust has been on the development of learning schemes and distributed algorithms for multiple decision-maker problems under different types of uncertainty. GRA

N89-26661# Stanford Univ., CA. Dept. of Statistics.
COMPARISONS OF IMPROVED BONFERRONI AND SIDAK/SLEPIAN BOUNDS WITH APPLICATIONS TO NORMAL MARKOV PROCESSES
Donald R. Hoover 23 Feb. 1989 20 p
(Contract N00014-86-K-0156)
(AD-A206699; TR-412) Avail: NTIS HC A03/MF A01 CSCL 12/3

The recent literature contains theorems improving on both the Standard Bonferroni inequality and the Sidak/Slepian inequalities. The application of these improved theorems to upper bounds for non-coverage of simultaneous confidence intervals on multivariate normal variables is explored. The improved Bonferroni upper bounds will always apply, while improved Sidak/Slepian bounds only apply to special cases. The improved Sidak/Slepian upper bound, if it applies, is always superior to the equivalent improved Bonferroni bound. This improvement, however, is not great when both methods are used to determine upper bounds for Type I error in the range of .01 to .10. It is shown that improved Sidak/Slepian bounds will apply to Normal Markov Processes, a commonly occurring and easily identifiable class of multivariate normal variables. GRA

N89-26662# Texas A&M Univ., College Station. Dept. of Electrical Engineering.
GEOMETRIC METHODS WITH APPLICATION TO ROBUST DETECTION AND ESTIMATION Final Report, 1 Jan. 1987 - 31 Dec. 1988
Don R. Halverson 1989 11 p
(Grant AF-AFOSR-0087-87; AF Proj. 2304)
(AD-A206999; AFOSR-89-0382TR) Avail: NTIS HC A03/MF A01 CSCL 12/9

A number of results were obtained pertaining to image compression, robust estimation, and robust signal detection. All of this work has admitted the presence of data whose statistics are imperfectly known. The results have featured adaptivity, flexibility, and nontraditional approaches. In order to employ more realistic statistical models, we have directed our research to admit nonstationarity and dependency. Much of the work in robust estimation admit nonstationarity and dependency. Much of the work in robust estimation and detection has employed a geometric approach which we have originated in past research. Our geometric techniques provide a quantitive way to measure the degree of robustness, thus offering the designer more flexibility in the meeting the performance/robustness, needs of the user. The most recent results have resulted in the admission of essentially arbitrary dependent data, thus leading the a number of important conclusions pertaining to signal detection and the estimation of a random variable. GRA

N89-26663 Gesellschaft fuer Mathematik und Datenverarbeitung, Saint Augustin (Germany, F.R.). Inst. fuer Methodische Grundlagen.
ANALYSIS OF A MULTIGRID STOKES SOLVER
Anton Niestegge, ed., Kristian Witsch (Duesseldorf Univ., Germany, F.R.), and Ulrich Trottenberg Dec. 1988 15 p
(GMD-355; ISSN-0723-0508; ETN-89-94611) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514
Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

The model problem analysis or local mode analysis is used to investigate the two level convergence rates for multigrid Stokes solvers. The solvers are based on the discretization on the staggered grid and the distributive relaxation of the continuity equation. The influence of the grid geometry is analyzed by also considering the Poisson equation on the semi-staggered grid. Various grid transfer operators are compared. For an isotropic discretization, simple transfer operators are sufficient to obtain optimal rates, but not in the anisotropic case. The theoretical results are compared with observed multigrid convergence rates. ESA

N89-26664# Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. de Physique Theorique.
LYAPUNOV EXPONENT FOR PRODUCTS OF MARKOVIAN RANDOM MATRICES
Andrea Crisanti, Giovanni Paladin, and Angelo Vulpiani (Aquila Univ., Italy) 11 Jan. 1989 24 p Submitted for publication
Prepared in cooperation with Istituto Nazionale di Fisica Nucleara, Rome, Italy and International Center for Mechanical Sciences, Rome, Italy
(Preprint-650; ETN-89-94724) Avail: NTIS HC A03/MF A01

The effect of finite memory on the Lyapunov exponent of products of random matrices is studied by considering Markov trials. The cases studied include one dimensional Anderson model with correlated random potentials, light propagation in media with correlated random optical indexes, and mime of the deterministic chaos appearing in dynamical systems with few degrees of freedom. The Lyapunov exponent is found to have the same qualitative shape as the inverse of the correlation length of the Markov process. ESA

N89-26665# Technische Univ., Eindhoven (Netherlands). Measurement and Control Group.
THE LINEAR REGRESSION MODEL: MODEL STRUCTURE SELECTION AND BIASED ESTIMATORS M.S. Thesis
J. G. M. Delissen Aug. 1988 85 p
(EUT-88-E-203; ISBN-90-6144-203-6; ISSN-0167-9708; ETN-89-94791) Avail: NTIS HC A05/MF A01

The consequences of (in)correct modeling are studied. It is shown that the estimates can be improved if a smaller model structure is chosen. Criteria for the selection of a model structure are given. The asymptotic behavior and sampling properties of these criteria are studied in the case that the best out of two model structures (the true model and a predefined smaller model structure) has to be chosen. It is shown that some criteria are asymptotically equivalent or asymptotically choose the right model structure. The risk involved with these criteria yields a range in the parameter space where it is smaller than the risk of the least squares estimator in the true model and a range where it is greater. Simulations of another selection procedure designed to improve the mean square error of estimating the impulse response indicate that it is not superior to a common similar model selection criterion. Principal component selection and ridge regression improve the least squares estimator only for a limited range in the parameter space. However, a class of biased estimators can be uniformly better than the least squares estimator. ESA

N89-26666# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abteilung Mathematische Verfahren und Datentechnik.
AN APPLICATION OF TESTS OF SIGNIFICANCE TO POINT AND CONFIDENCE ESTIMATION AND TO TEST MODEL VERIFICATION FOR PARAMETER IDENTIFICATION
Fro Hammelrath Dec. 1988 31 p In GERMAN; ENGLISH summary
(DFVLR-Mitt-88-34; ISSN-0176-7739; ETN-89-94981) Avail: NTIS HC A03/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, DM 15

It is argued that in many practical applications, identification methods, such as maximum likelihood or least squares do not provide sufficient information about the quality of the estimates and the model. The concept of a test of significance gives criteria whether to accept or to reject a specified parameter value or a given model. It also provides a method to calculate a confidence region and a point estimate. For example, maximum likelihood estimation is a special application of these methods. For statistics with unknown distribution a Monte-Carlo approach is suggested. ESA

66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

N89-26667*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
STRATEGIES FOR AUTOMATIC PLANNING: A COLLECTION OF IDEAS
Carol Collins, Julia George, and Elaine Zamani 1 May 1989 28 p
(Contract NAS7-918)
(NASA-CR-184797; JPL-Publ-89-12; NAS 1.26:184797) Avail: NTIS HC A03/MF A01 CSCL 12B

The main goal of the Jet Propulsion Laboratory (JPL) is to obtain science return from interplanetary probes. The uplink process is concerned with communicating commands to a spacecraft in order to achieve science objectives. There are two main parts to the development of the command file which is sent to a spacecraft. First, the activity planning process integrates the science requests for utilization of spacecraft time into a feasible sequence. Then the command generation process converts the sequence into a set of commands. The development of a feasible sequence plan is an expensive and labor intensive process requiring many months of effort. In order to save time and manpower in the uplink process, automation of parts of this process is desired. There is an ongoing effort to develop automatic planning systems. This has met with some success, but has also been informative about the nature of this effort. It is now clear that innovative techniques and state-of-the-art technology will be required in order to produce a system which can provide automatic sequence planning. As part of this effort to develop automatic planning systems, a survey of the literature, looking for known techniques which may be applicable to our work was conducted. Descriptions of and references for these methods are given, together with ideas for applying the techniques to automatic planning. Author

N89-26668# California Univ., Berkeley. Dept. of Mathematics.
USE OF AN INDEFINITE INNER PRODUCT FOR COMPUTING DAMPED NATURAL MODES
H. C. Chen and B. N. Parlett Nov. 1988 37 p
(Grant AF-AFOSR-0048-88)
(AD-A206867; PAM-435) Avail: NTIS HC A03/MF A01 CSCL 12/2

A quadratic eigenvalue problem with symmetric positive definite coefficient matrics may be reduced to linear form while retaining symmetry in the new coefficients but neither of them will be positive definite. Formally the symmetric Lanczos algorithm and subspace iteration may be used to computer some eigenpairs of the linear problem. The trouble is that the basis vectors are orthogonal with respect to an indefinite inner product so there is no assurance that will be linearly independent. Nevertheless this is an attractive way to solve the original problem and we discuss how to implement it and how it relates to the unsymmetric Lanczos procedures. We discuss complex origin shifts, reothogonalization, and error bounds. Several methods for solving the reduced problem are mentioned but we have no fully satisfying technique. Some dangers are described and examples are given comparing our Lanczos program with a modified subspace iteration. GRA

N89-26669# Institute for Defense Analyses, Alexandria, VA.
SDI (STRATEGIC DEFENSE INITIATIVE) BATTLE MANAGEMENT/C3 (COMMAND, CONTROL AND COMMUNICATIONS) NETWORKING TECHNOLOGY PROGRAM PLAN Final Report, Jan. 1987 - Oct. 1988
Robert Botta and Sharon Noll Dec. 1988 163 p
(Contract MDA903-84-C-0031)
(AD-A206885; AD-E501085; IDA-M-305; IDA/HQ-87-32186)
Avail: NTIS HC A08/MF A01 CSCL 15/3

The Institute for Defense Analyses (IDA) has collected and analyzed information on network technology that is relevant to Battle Management Command, Control, and Communications (BM/C3). This memorandum report represents a program plan that will provide the SDIO BM C3 directorate with administrative and technical insight into network technology. This program plan focuses on C3 network concepts and provides information and analysis to the SDIO to be used in formulating budget requirements for FY 1988 and beyond. Based upon analysis of network requirements and ongoing programs, recommendations have been made for research areas that should be funded, including both the continuation of current work and the initiation of new tasks. While emphasis here is on the SDIO-funded tasks, other relevant government-sponsored and commercial efforts, such as packet radio networks, also have been examined. GRA

N89-26670# Strategic Defense Initiative Organization, Washington, DC.
REPORT TO THE CONGRESS ON THE STRATEGIC DEFENSE INITIATIVE, 1989
13 Mar. 1989 355 p
(AD-A206944) Avail: NTIS HC A16/MF A01 CSCL 15/3

This report summarizes the SDI legacy of President Reagan, who launched the initiative with his speech of March 23, 1983. It describes in detail our current assessment of the best program for the resolution of remaing technical issues, the validation of technologies, and the demonstration of our ability to integrate them.

This program of research, development and testing would, if adequately funded, support a fully informed decision by the President and Congress in the future on whether to deploy a strategic defense of the United States. Such defenses could enhance deterrence and increase stability. In an effort to reduce the overall costs of a first-phase Strategic Defense System, the DOD recently completed an intensive review of the modifications made to date toward this end. The projected cost of the first phase of a Strategic Defense system has been reduced dramatically from the earlier estimate of $115 billion to $69 billion while maintaining the capability to contribute to deterrence. The review also confirmed that SDI is proceeding in the right direction toward development of a comprehensive space and ground based Strategic Defense System. GRA

N89-26671# Michigan Univ., Ann Arbor. Dept. of Industrial and Operations Engineering.
MULTISTAGE STOCHASTIC PLANNING MODELS USING PIECEWISE LINEAR RESPONSE FUNCTIONS
John R. Birge Apr. 1989 12 p
(Contract N00014-86-K-0628)
(AD-A207203; TR-89-11) Avail: NTIS HC A03/MF A01 CSCL 12/4

Random outcomes can often produce significant effects on planning decisions that consider several time periods. Multistage stochastic programs can model these decisions but implementations are generally restricted to a limited number of scenarios in each period. An alternative approximation scheme is presented that can obtain lower and upper bounds on the optimal objective value in these stochastic programs. The method is based on building response functions to future outcomes that depend separably on the variation of random parameters around the limited set of scenarios that is initially provided. For stochastic linear programs, the resulting optimization problem involves an objective with a limited number of nonlinear terms subject to linear constraints. The method can be incorporated into various alternative procedures for solving multistage stochastic linear programs with finite numbers of scenarios. Section 2 discusses the basic model and alternative approaches. Section 3 then discusses the basic properties of piecewise linear response functions. The fourth section presents a basic model for a single scenario and randomness restricted to constraint levels. The fifth section extends this to multiple scenarios with varying scenario ranges and to possibilities for randomness among the constraint vectors. GRA

67 THEORETICAL MATHEMATICS

Includes topology and number theory.

N89-26672# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
THE BOX AND HAUSDORFF DIMENSION OF SELF-AFFINE SETS
Tim Bedford and Mariusz Urbanski, G1128406 1988 19 p
(Rept-88-80; ISSN-0922-5641; ETN-89-94909) Copyright Avail: NTIS HC A03/MF A01

Under a natural assumption the Hausdorff dimension of a measure conically associated to a given self-affine set is computed. A simplified proof of Bowen's formula for the box dimension of self-affine sets is given. A condition for the box dimension and Hausdorff dimension to be equal is proved, and a collection of examples in which this condition can be checked is discussed. ESA

N89-26673# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
A PREFERENCE LOGIC FOR NON-MONOTONIC REASONING
Nico Roos 1988 29 p
(Rept-88-94; ISSN-0922-5641; ETN-89-94914) Copyright Avail: NTIS HC A03/MF A01

A generalization of the first order predicate logic is defined. On the premises of this logic a preference relation can be specified. By using this preference relation it is possible to describe non-monotonic reasoning in a very natural way. In this non-monotonic logic defalut rules can be formulated. It is also possible to derive new default rules. Unlike other forms of non-monotonic reasoning, this logic has an executable deduction process. In this deduction process truth maintenance is integrated. ESA

70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

N89-26674# Johns Hopkins Univ., Laurel, MD. Applied Physics Lab.
ORGANO-METALLIC ELEMENTS FOR ASSOCIATIVE INFORMATION PROCESSING Final Report, 15 Apr. 1985 - 15 Apr. 1988
Richard S. Potember and Theodore O. Poehler 15 Jan. 1989 78 p
(Grant AF-AFOSR-0169-85; AF Proj. 2303)
(AD-A206730; AFOSR-89-0388TR) Avail: NTIS HC A05/MF A01 CSCL 20/3

In the three years of the program we have: (1) built and tested a 4 bit element matrix device for possible use in high density content-addressable memories systems; (2) established a test and evaluation laboratory to examine optical materials for nonlinear effects, saturable absorption, harmonic generation and photochromism; (3) successfully designed, constructed and operated a codeposition processing system that enables organic materials to be deposited on a variety of substrates to produce optical grade coatings and films. This system is also compatible with other traditional microelectronic techniques; (4) used the sol-gel process with colloidal AgTCNQ to fabricate high speed photochromic switches; (5) develop and applied for patent coverage to make VO2 optical switching materials via the sol-gel processing using vanadium (IV) alkoxide compounds. GRA

N89-26675# Department of the Army, Washington, DC.
PERIODIC PERMANENT MAGNET STRUCTURE Patent Application
Herbert A. Leupold, inventor (to Army) 17 Mar. 1989 17 p
Filed 17 Mar. 1989
(AD-D014061; US-Patent-Appl-SN-326715) Avail: NTIS HC A03/MF A01 CSCL 20/3

This patent application discloses a periodic permanent magnet stack comprises a plurality of aligned, juxtaposed, hollow hemispherical flux sources each of which produces a uniform high-field in its hemispherical central cavity. The magnetic field orientations in the central cavities are axially directed and alternate or reverse in direction from hemisphere to hemisphere. An axial bore hole through the stack provides a continuous channel or path through which a beam of charged particles will travel. GRA

N89-26676# Technische Univ., Eindhoven (Netherlands). Fundamentals of Mechanical Engineering Section.
THE DYNAMICS OF SYSTEMS OF DEFORMABLE BODIES Ph.D. Thesis
Wilhelmus Petrus Koppens 1989 112 p
(ISBN-90-9002-579-0; ETN-89-94876) Avail: NTIS HC A06/MF A01

A mathematical description of the dynamic behavior of systems of interconnected deformable bodies is presented. The displacement field of a body is resolved into a displacement field due to a rigid body motion and a displacement field due to deformation. In order to get an unambiguous resolution, the displacement field due to deformation is required to be such that in cannot represent rigid body motions. This is achieved by prescribing either displacements due to deformation of selected

particles or mean displacements due to deformation. Starting from the equations of motion of a particle of the body, a variational formulation of the equations of motion of the free body is derived. These equations are simpler is the mean displacements due to deformation are equal to zero. Approximate equations of motion are obtained by approximating the displacement field due to deformation by a linear combination of a set of assumed displacement fields. Three methods for generating assumed displacement fields are described: the assumed-modes method, the finite element method, and the modal synthesis method.
ESA

71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution*.

N89-26677 Department of the Navy, Washington, DC.
ACOUSTIC SIGNAL OPTICAL CORRELATOR USING A LIGHT EMITTING DIODE ARRAY Patent
Edward J. Fogarty, inventor (to Navy) 14 Feb. 1989 5 p
Filed 1 May 1986
(AD-D013971; US-Patent-4,805,158; US-Patent-Appl-SN-858156; US-Patent-Class-367-125) Avail: US Patent and Trademark Office CSCL 20/6

An optical correlator using a light emitting diode array is presented in which analog signals from two spaced sensors are correlated in order to locate and track a target. One signal is clipped and digitized and clocked through a shift register, and the other signal is delayed. The shift register is coupled to a light emitting diode (LED) array, element for element. Each shift register element modulates its corresponding LED element. The delayed signal is also connected at its output to the LED array via a transistor, and modulates each LED element. Therefore, the LED elements emit light in proportion to the product of the two signals. The emitted light is focused onto a charge coupled device (CCD) imaging array where it is integrated over a period of time before being sent to an integrator and output display device. The output is the correlation function versus the time delay between the two signals. Successive outputs display the movement of targets. Circuit design mitigates inherent errors within the system. GRA

N89-26678# Purdue Univ., West Lafayette, IN. School of Engineering.
ADAPTIVE REAL-TIME CONTROL FOR THREE-DIMENSIONAL ACTIVE ATTENUATION OF SOUND
G. Shoureshi, R. J. Bernhard, G. Batta, J. Dohner, C. Mollo, J. Warner, and D. Waters Apr. 1988 165 p
(Grant NSF MSM-85-05834)
(PB89-160808; HL88-18P; Rept-1451-2; NSF/ENG-88022) Avail: NTIS HC A08/MF A01 CSCL 20A

Three objectives were addressed: to investigate the performance of active noise control systems and develop models of acoustic plants which could be used to design and implement active controllers for 3-D acoustic systems; to integrate these models into modern control formulations for active noise control applications; and to implement active noise control and investigate feasibility of using real-time adaptive control algorithms in several realistic three-dimensional applications. Conventional boundary element acoustical prediction schemes were used to develop a generalized prediction method to evaluate the performance of active noise control configurations for conditions where the acoustic environment could be specified. Models were developed which could be integrated into modern control formulations for analysis of stability, observability, and controllability of closed loop systems. GRA

N89-26679*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A NEW CLASS OF RANDOM PROCESSES WITH APPLICATION TO HELICOPTER NOISE Annual Report No. 2
Jay C. Hardin and A. G. Miamee (Hampton Inst., VA.) 1989 25 p
(Grant NAG1-768)
(NASA-CR-185037; NAS 1.26:185037) Avail: NTIS HC A03/MF A01 CSCL 20A

The concept of dividing random processes into classes (e.g., stationary, locally stationary, periodically correlated, and harmonizable) has long been employed. A new class of random processes is introduced which includes many of these processes as well as other interesting processes which fall into none of the above classes. Such random processes are denoted as linearly correlated. This class is shown to include the familiar stationary and periodically correlated processes as well as many other, both harmonizable and non-harmonizable, nonstationary processes. When a process is linearly correlated for all t and harmonizable, its two-dimensional power spectral density S(x)(omega 1, omega 2) is shown to take a particularly simple form, being non-zero only on lines such that omega 1 to omega 2 = + or - r(k) where the r(k's) are (not necessarily equally spaced) roots of a characteristic function. The relationship of such processes to the class of stationary processes is examined. In addition, the application of such processes in the analysis of typical helicopter noise signals is described. Author

N89-26680# Defence Research Establishment Atlantic, Dartmouth (Nova Scotia).
PREDICTION OF ACOUSTIC CAVITY MODES BY FINITE ELEMENT METHODS
Thomas A. Vernon and S. Tang Mar. 1989 24 p
(AD-A206921; DREA-TC-89/302) Avail: NTIS HC A03/MF A01 CSCL 20/1

A finite element method for acoustic cavity modal analysis is presented. The approach utilizes the VAST finite element program eigensolution routines operating on equivalent acoustic mass and stiffness matrices generated from the program ACOUSTIC. Both closed and open cavities can be treated, within the assumption of rigid boundaries. Two elements have been implemented in ACOUSTIC; a 20-noded isoparametric brick element and an 8-noded isoparametric axisymmetric element. The performance of the analysis system has been evaluated via comparison to both analytical and experimental results, and good agreement has been found. GRA

N89-26681# Pennsylvania State Univ., University Park. Applied Research Lab.
HIGH RESOLUTION ACOUSTICAL IMAGING M.S. Thesis
Kent E. Eschenberg May 1989 260 p Sponsored by Naval Sea Systems Command, Washington, DC
(AD-A207008; ARI/PSU/TR-89-001) Avail: NTIS HC A12/MF A01 CSCL 20/1

Pressure waves, detected by an array of receivers, can be analyzed to determine the location of the acoustic source, or the location of objects which the waves encountered along their path. This thesis examines high resolution methods which use a linear array to locate stationary objects which have scattered the pressure waves. Several new methods are explored through simulations in air. A theoretical examination of all of the basic and high resolution acoustical imaging methods is first conducted. These methods include holographic reconstruction, beamforming, a correlation method, autoregressive-moving average (ARMA) spectral estimators and minimum energy methods. This examination summarizes the well-known ability of these methods to locate sound sources while making some new observations on the ability of these methods to located sound scatterers. One of the methods which was examined used the concept of a fictitious source. This concept is developed to yield a new imaging approach called the pattern-match method which is similar to the temporal signal processing technique called the matched filter. In addition, a new technique for comparing signals is used to develop a variation of the pattern-match method called the mismatch method. A series of simulations is used to examine the ability of both methods to locate either one or two acoustic sources. GRA

N89-26682# Manchester Univ. (England). Dept. of Engineering.
ONE DIMENSIONAL PROPAGATION OF SHOCK WAVES THROUGH CLOUDS
Xin Xin Zhou Oct. 1987 118 p
(AERO-Rept-8707; ETN-89-94947) Avail: NTIS HC A06/MF A01

The finite difference methods of Lax-Wendroff (two step) and MacCormack are used to solve the flow of a plane shock wave entering and propagation through a semi-infinite two phase mixture consisting of an inert gas, water vapor, and water droplets. Finite difference methods were studied for an air-air shock tube. It is concluded that the antidiffusion method of Boris and Book (1973, 74) is a powerful corrective procedure to the more basic methods. The results for the near field transmitted wave obtained by the finite difference approach are in good agreement with results by Kao (1983) using the method of characteristics. The advantage of the finite difference method is its adaptability to two and three dimensional problems. ESA

N89-26683*# United Technologies Research Center, East Hartford, CT.
NOISE PRODUCED BY TURBULENT FLOW INTO A ROTOR: THEORY MANUAL FOR NOISE CALCULATION Final Report
R. K. Amiet Jun. 1989 36 p
(Contract NAS1-17763)
(NASA-CR-181788; NAS 1.26:181788) Avail: NTIS HC A03/MF A01 CSCL 20A

An analysis is presented for the calculation of noise produced by turbulent flow into a helicopter rotor. The method is based on the analysis of Amiet for the sound produced by an airfoil moving in rectilinear motion through a turbulent flow field. The rectilinear motion results are used in a quasi-steady manner to calculate the instantaneous spectrum of the rotor noise at any given rotor position; the overall spectrum is then found by averaging the instantaneous spectrum over all rotor azimuth angles. Account is taken of the fact that the rotor spends different amounts of retarded time at different rotor positions. Blade to blade correlation is included in the analysis, leading to harmonics of blade passing frequency. The spectrum of the turbulence entering the rotor is calculated by applying rapid distortion theory to an isotropic turbulence spectrum, assuming that the turbulence is stretched as it is pulled into the rotor. The inputs to the program are obtained from the atmospheric turbulence model and mean flow distortion calculation, described in another volume of this set of reports. The analytical basis is provided for a module which was incorporated in NASA's ROTONET helicopter noise prediction program. Author

72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

N89-26684*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
RECENT ADVANCES IN ELECTRONIC STRUCTURE THEORY AND THEIR INFLUENCE ON THE ACCURACY OF AB INITIO POTENTIAL ENERGY SURFACES
Charles W. Bauschlicher, Jr., Stephen R. Langhoff, and Peter R. Taylor (Eloret Corp., Sunnyvale, CA.) [1988] 21 p
(Contract NCC2-371)
(NASA-CR-182895; NAS 1.26:182895) Avail: NTIS HC A03/MF A01 CSCL 20H

Recent advances in electronic structure theory and the availability of high speed vector processors have substantially increased the accuracy of ab initio potential energy surfaces. The recently developed atomic natural orbital approach for basis set contraction has reduced both the basis set incompleteness and superposition errors in molecular calculations. Furthermore, full CI calculations can often be used to calibrate a CASSCF/MRCI approach that quantitatively accounts for the valence correlation energy. These computational advances also provide a vehicle for systematically improving the calculations and for estimating the residual error in the calculations. Calculations on selected diatomic and triatomic systems will be used to illustrate the accuracy that currently can be achieved for molecular systems. In particular, the F+H2 yields HF+H potential energy hypersurface is used to illustrate the impact of these computational advances on the calculation of potential energy surfaces. Author

N89-26685*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ON THE ELECTRON AFFINITIES OF THE Ca, Sc, Ti AND Y ATOMS
Charles W. Bauschlicher, Jr., Stephen R. Langhoff, and Peter R. Taylor (Eloret Corp., Sunnyvale, CA.) [1988] 8 p
(Contract NCC2-371)
(NASA-CR-181277; NAS 1.26:181277) Avail: NTIS HC A02/MF A01 CSCL 20H

For the Ca, Sc, Ti and Y atoms calculations are performed for the ground states of the neutrals and the ground and several low-lying excited states of the negative ions. Overall the computed electron affinities are in good accord with experiment. The calculations show the rapid stabilization of the 3d orbital relative to the 4p as the nuclear charge increases. The 3F(0) and 3D(0) terms are found to be close in energy in Sc(-) and in Y(-). This confirms earlier speculation that some of the peaks in the photodetachment spectra of Y(-) originate from the bound excited 3F(0) term of Y(-). Author

N89-26686# Massachusetts Inst. of Tech., Cambridge. Dept. of Chemistry.
ENERGY AND CHEMICAL CHANGE Final Report, 1 Nov. 1986 - 1 Nov. 1988
R. D. Levine and J. L. Kinsey 27 Nov. 1988 30 p
(Grant AF-AFOSR-0011-86; AF Proj. 2303)
(AD-A206595; AFOSR-89-0434TR) Avail: NTIS HC A03/MF A01 CSCL 20/5

The algebraic approach to the structure and dynamics of molecules has been applied in a number of ways: The ability to compute the spectra of energy-rich molecules has been demonstrated. Broad gateway states have been examined for vibrationally excited molecules. A link between the intramolecular dynamics and the statistical analysis of spectra has been established. The underlying potential energy has been determined directly from the observed spectra. The intramolecular dynamics of vibrationally excited acetylene has been studied and the spectral signatures of vibrational energy pathways have been examined. GRA

N89-26687# Air Force Academy, CO.
MOPAC WORKSHOP MANUAL, 2ND EDITION Technical Report, Aug. 1987 - May 1988
Chester J. Dymek, Jr., James J. Stewart, and Donn M. Storch 1 Jun. 1988 61 p
(AD-A206649; FJSRL-TR-88-0002) Avail: NTIS HC A04/MF A01 CSCL 07/4

MP4OPAC is a general-purpose, semi-empirical molecular orbital program for the study of chemical reactions involving molecules, ions, and linear polymers. It implements the semi-empirical Hamiltonians, MNDO, AMI, and MINDO/3, and combines the calculations of vibrational spectra, thermodynamic quantities, isotopic substitution effects, and force constants in a fully integrated program. This manuscript is designed to be used by participants in a 2-day workshop on the MOPAC computational chemistry program. It is aimed at beginning users, assuming some fundamental knowledge of quantum mechanics, but not requiring familiarity with the higher mathematics involved in molecular orbital calculations. This second edition adds three appendices containing information found to be of interest to attendees of the first three workshops. GRA

N89-26688# State Univ. of New York, Buffalo. Dept. of Chemistry.
INTERFERENCE PHENOMENA IN ATOMIC EMISSION NEAR AN INTERFACE: PURE CLASSICAL EFFECTS IN QUANTUM RADIATION
Henk F. Arnoldus and Thomas F. George Mar. 1989 29 p
(Contract N00014-86-K-0043)
(AD-A206700; UBUFFALO/DC/89/TR-95) Avail: NTIS HC A03/MF A01 CSCL 20/5

The emission of fluorescence by an atom which is close to the surface of an optically-reflecting medium is examined. All linear media, like a dielectric, a metal, a thin film on a substrate, etc., are dealt with in a unified way. It appears that only the classical Fresnel coefficients for reflection of a plane wave enter the expression for the radiation field. The reflection by nonlinear media is also considered, and in particular optical phase conjugators which operate via degenerate four-wave mixing. The two strong laser beams which pump the nonlinear crystal are assumed to be in resonance with an atomic transition frequency. It is shown that the angular intensity distribution and the polarization of the fluorescence are determined by classical interference of waves, although the radiation is pure quantum mechanical. It is also shown that an atom in its ground state can fluoresce when it is near a phase conjugator, and that this phenomenon follows from the classical properties of this quantum radiation field. GRA

N89-26689# Pennsylvania State Univ., University Park. Dept. of Chemistry.
STUDIES ON IONS AND NEUTRALS DESORBED FROM SOLID SURFACES BY ION AND ELECTRON BOMBARDMENT Final Report, 1 Nov. 1984 - 31 Oct. 1988
Nicholas Winograd 24 Mar. 1989 23 p
(Grant AF-AFOSR-0028-86; AF Proj. 2303)
(AD-A206734; AFOSR-89-0398TR) Avail: NTIS HC A03/MF A01 CSCL 20/5

This project was aimed toward increasing our fundamental knowledge of the details of the interaction of energetic particles with solid surfaces. These studies included the measurement of the angular and energy contributions of the yield of desorbed ions by Secondary Ion Mass Spectrometry (SIMS). In addition, we developed a novel angle and energy resolved detector capable of measuring for the first time the yield of neutral particles desorbed from monolayers. This detector utilized multi-photon resonance ionization of the ejected atoms which occur at efficiencies approaching 100 percent. The results of the experimental measurements were coupled to classical dynamics calculations of the ion impact event. This approach has been pursued to utilize ion beams to examine the structure of surface layers through anisotropies observed in the angular distributions. A variety of materials including alloys, semi-conductors and organic monolayers on metals were candidates as model system. The experiments have opened new avenues for using ion beam methods for the trace analysis of important electronic materials at unprecedented sensitivity limited. GRA

N89-26690# North Texas State Univ., Denton. Dept. of Physics.
TWO-PHOTON ABSORPTION CHARACTERIZATION Interim Performance Report, 28 Aug. - 27 Nov. 1988
Chris L. Littler and David G. Seiler Jan. 1989 17 p
(Contract DAAB07-87-C-F094; DA Proj. 1L1-61102-A-31-B)
(AD-A207197) Avail: NTIS HC A03/MF A01 CSCL 17/5

Magneto-Optical measurements of Hg(1-X)Cd(X)Te alloys have provided a new means of studying impurities and defects in this important II-VI material. Two-photon magnetoabsorption (TMPA) has been used to accurately determine the temperature dependence of the energy gap of various HgCdTe alloys, revealing behavior that deviates from currently accepted models. In addition, magneto-optical techniques were used to detect the presence of both shallow and deep impurities/defects and accurately determine their activation energies, thus providing information necessary for understanding the electrical and optical properties of the material. GRA

N89-26691# Calabria Univ., Arcavacta di Rende (Italy). Dipartimento di Fisica.
RAMAN SPECTRA OF WATER IN THE TRANSLATIONAL AND LIBRATIONAL REGIONS. 3: TEMPERATURE EVOLUTION BY COMPUTER SIMULATION WITH THE TIP4P POTENTIAL
M. A. Ricci, G. Ruocco, and M. Sampoli (Florence Univ., Italy) 30 Sep. 1988 44 p Submitted for publication Prepared in cooperation with Rome Univ., Italy
(Preprint-626; ETN-89-94707) Avail: NTIS HC A03/MF A01

A molecular dynamics simulation is presented. Depolarized and isotropic spectra are calculated at five temperatures in the 250 to 380 K range are compared with the experimental data. The relevance of collision induced contributions is stressed and in particular the dipole induced dipole is shown to dominate the depolarized spectra, while contributions to the effective molecular polarizability account for the low frequency isotropic spectrum. ESA

N89-26692# Rome Univ. (Italy). Dipartimento di Fisica.
DIFFRACTION STUDIES OF LIQUID DEUTERIUM SULFIDE
C. Andreani, V. Merlo, M. A. Ricci, G. C. Ruocco, and A. K. Soper (Rutherford High Energy Lab., Chilton, England) 17 Oct. 1988 16 p Submitted for publication Sponsored by the United Kingdom Science and Engineering Research Council and Consiglio Nazionale della Ricerche, Rome, Italy
(Preprint-632; ETN-89-94712) Avail: NTIS HC A03/MF A01

The static structure factor of orthobaric liquid deuterium sulfide is investigated by neutron diffraction. Measurements were performed at 288 and 205 K. A comparison with a molecular dynamics simulation employing a 4PCLJ potential is discussed, showing the relevance of multipolar interactions in determining the orientational correlations between neighboring molecules. ESA

N89-26693# Istituto Nazionale di Fisica Nucleare, Rome (Italy).
MATRIX ELEMENTS OF LEFT-RIGHT FOUR FERMION OPERATORS AND THE ELECTROPENGUIN CONTRIBUTION TO EPSILON'/EPSILON IN LATTICE QCD WITH WILSON FERMIONS
E. Franco, L. Maiani, G. Martinelli, and A. Morelli (Rome Univ., Italy) 24 Oct. 1988 23 p Submitted for publication
(Preprint-633; ETN-89-94713) Avail: NTIS HC A03/MF A01

The K-pi and K-pi-pi elements of left-right four fermion operators in quenched lattice QCD at beta=6 are computed. The soft-pion relations derived from the chiral structure of the operators are checked. A large enhancement of matrix elements is observed and interpreted as the effect of a scalar octet pole in the pi-K channel. This observation has implications for the related calculation of weak matrix elements. ESA

N89-26694# Rome Univ. (Italy). Dipartimento di Fisica.
PHENOMENOLOGY FROM LATTICE QCD
G. Martinelli (Rome Univ., Italy) 13 Dec. 1988 54 p Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-645; ETN-89-94721) Avail: NTIS HC A04/MF A01

Theoretical aspects, numerical techniques, and results in the computation of hadronic matrix elements using lattice QCD are reviewed. Particular attention is devoted to the discussion of the systematic errors present in the lattice approach, especially those coming from the quenched approximation and from effects due to the finiteness lattice spacing. ESA

N89-26695# Rome Univ. (Italy). Dipartimento di Fisica.
NEUTRINOS ON THE LATTICE. THE REGULARIZATION OF A CHIRAL GAUGE THEORY
A. Borrelli, L. Maiani, G. C. Rossi, R. Sisto (Lecce Univ., Italy), and M. Testa 24 Jan. 1989 28 p Submitted for publication Sponsored in part by the Italian Ministry of Public Education Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-655; ETN-89-94728) Avail: NTIS HC A03/MF A01

The explicit construction of a regularized lattice with or without

elementary Higgins fields is discussed. In contrast with vector-like cases, the regularization breaks the chiral gauge invariance. It is argued that such a breaking can be compensated by the addition to the naive lattice action of all possible, renormalizable counterterms. The requirement that the Green functions thus computed satisfy the Slavnov-Taylor identities of symmetry determines the coefficients of the counterterms. It is shown how the procedure works in one loop perturbation theory. The prospects for performing numerical simulations of chiral gauge theories are briefly discussed. ESA

N89-26696# Rome Univ. (Italy). Dipartimento di Fisica.
YUKAWA LATTICE THEORY AND NON-PERTURBATIVE UPPER BOUNDS TO THE FERMION MASS
A. Borrelli, L. Maiani, G. C. Rossi, R. Sisto, and M. Testa (Lecce Univ., Italy) 24 Jan. 1989 7 p Submitted for publication
Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-656; ETN-89-94729) Avail: NTIS HC A02/MF A01

The construction of a chiral, lattice Yukawa theory is considered. The breaking of the chiral symmetry is compensated by introducing the Wilson terms. It is found that three further counterterms must be added to the naive lattice action. Fixing counterterm coefficients in numerical simulations is discussed. Pathologies that could prevent the regularized theory reaching the desired continuum theory are pointed out. Once counterterms are fixed, upper bounds to the fermion mass are obtained along similar lines to those discussed by Dashen and Neuberger (1983) for the Higgs boson mass. ESA

N89-26697 National Physical Lab., Teddington (England). Div. of Radiation Science and Acoustics.
NPL CONTRIBUTION TO A EURADOS WORKING COMMITTEE 4 INTERCOMPARISON OF UNFOLDING CODES FOR BONNER SPHERE DATA
D. J. Thomas Dec. 1988 38 p
(NPL-RS(EXT)-112; ISSN-0143-7135; ETN-89-94823) Copyright Avail: National Physical Lab., Teddington, Middlesex, TW17 0LW, United Kingdom

All participants to the intercomparison of codes used for deriving neutron spectra received data for 12 spectra, but not all participants the same. In the case reported details of two data set results unfolded with the computer program STAY'SL are given. The program estimates correctly the uncertainties if valid uncertainty estimates are available for the a priori spectrum. The importance of the exercise is discussed. ESA

N89-26698# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands). Section Nuclear Physics.
ON THE POSSIBLE OBSERVATION OF LIGHT NEUTRAL BOSONS IN NUCLEAR EMULSIONS
F. W. N. deBoer and R. vanDantzig 1 Dec. 1988 10 p
(NIKHEF-K/PIMU/88-1; ETN-89-94916) Avail: NTIS HC A02/MF A01

Electron-positron pairs apparently resulting from the decay of light neutral particles emitted in relativistic heavy ion collisions, reported by El-Nadi and Badawy (1988) are considered. The events, observed in nuclear emulsions, are similar to data from 35 years ago that caused the estimate for the liftime of the neutral pion to be wrong by almost two orders of magnitude for about a decade. The data are consistent with the production and decay of bosons with masses around 1.1, 2.1, and 9 MeV and lifetimes of 10 to the minus 16th to minus 15th power sec. ESA

73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

N89-26699# Continuous Electron Beam Accelerator Facility, Newport New, VA.
THE CEBAF CRYOGENIC SYSTEM
W. C. Chronis, D. Arenius, D. Kashy, M. Keesee, and C. H. Rode 1989 6 p
(Contract DE-AC05-84ER-40150)
(CEBAF-PR-89-007) Avail: NTIS HC A02/MF A01

The CEBAF (continuous electron beam accelerator facility) superconducting linear accelerator incorporates cryogenic refrigeration equipment at three locations within the site: the Central Helium Liquefier, located in the center of the accelerator; the experimental end station refrigerator; and the test laboratory refrigerator located in the Cryogenic Test Facility (CTF) adjacent to the test laboratory. These three cryogenic systems are described in detail. The CEBAF cryogenic system will provide 2K refrigeration to the linacs of the accelerator and test laboratory and 4.5K refrigeration for the end station experimental halls. The Central Helium Liquefier and the test laboratory systems will produce 45K supercritical gaseous helium for shield refrigeration. Liquid nitrogen shields will also be incorporated in the test laboratory and end stations. K.C.D.

N89-26700# Continuous Electron Beam Accelerator Facility, Newport New, VA.
OPTICAL DESIGN OF THE CEBAF BEAM TRANSPORT SYSTEM
D. R. Douglas, R. C. York, and J. Kewisch 1989 6 p
(Contract DE-AC05-84ER-40150)
(CEBAF-PR-89-008) Avail: NTIS HC A02/MF A01

Recent modifications to the beam transport system design are described. These include: detailing of injector optics and inclusion of an isochronous injection chicane in order to avoid bunch lengthening during injection, use of a staircase spreader/recombiner design in order to reduce error sensitivity, use of 1 GHz RF separators for separation and extraction of multiple beams to reduce emittance dilution, and modification of the beam transport system to accommodate a fifth recirculation of the beam. The isochronicity of the injector chicane design and the choice of a lower frequency for the RF separator extraction system have made the machine phase space design values inherently more achievable. The new staircase spreader/recombiner design has reduced sensitivity to lattice errors by a factor of two. This gain in reduced sensitivity is offset by the increased lattice error sensitivity of the five-pass design over that for the previous four-pass design. K.C.D.

N89-26701# Continuous Electron Beam Accelerator Facility, Newport New, VA.
BEAM TRANSPORT MAGNETS FOR CEBAF
L. H. Harwood, G. Biallas, J. R. Boyce, W. Heilbrunn, K. Johnson, and R. C. York 1989 6 p
(Contract DE-AC05-84ER-40150)
(CEBAF-PR-89-006) Avail: NTIS HC A02/MF A01

With respect to the optical system, the challenging parameters of the Continuous Electron Beam Accelerator Facility (CEBAF), a five pass recirculating electron linac, are the design goals for the emittance and energy spread of its beam. The design goals are an emmitance of 2x10(-9)m-rad at E less than 1 GeV and an energy spread of delta E/E (4 sigma) of 10(-4). The nominal operating energy range of the machine is to be from 0.5 to 4 GeV. The optics to make this possible were developed previously. The magnetic elements specified by the optics design are not, in general, extraordinary. There are, however, many magnets: 1047 corrector dipoles, 390 major dipoles, 707 quadrupoles, 96 sextupoles, 26 septa and one lambertson septum, for a total of 2267 individual magnets. Furthermore, the fact that the

quadrupoles, sextupoles, and correctors are to be individually powered to provide flexibility in tuning the optics lattice leads to restrictions on their design parameters. To ensure that the required magnetic parameters are achieved, all magnets will be magnetically mapped before installation. Therefore, systems to accurately and rapidly measure the multipoles and major dipoles are required. Present planning and the results of tests performed on the system to date are outlined. Author

N89-26702# Institute for Defense Analyses, Alexandria, VA.
A REPORT ON THE POSSIBLE BENEFITS OF USING HIGH-TEMPERATURE SUPERCONDUCTOR MATERIALS IN PARTICLE ACCELERATOR DESIGN Final Report, Jun. - Sep. 1987
Leslie Cohen, Robert Collins, and Bohdan Balko Dec. 1988 25 p
(Contract MDA903-84-C-0031)
(AD-A207174; AD-E501096; IDA-M-444; IDA/HQ-88-33226)
Avail: NTIS HC A03/MF A01 CSCL 20/7

This report discusses different design concepts for particle beam accelerators. It demonstrates that with the use of high temperature superconducting materials, a more compact, lighter, and more robust accelerator design can be realized for the space based Neutral Particle Beam (NPB) accelerator. GRA

N89-26703# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
GENERATION OF ELECTRON BEAMS IN CYCLOTRON MOTION AND ITS INTERACTION WITH ELECTROMAGNETIC FIELDS IN WEAKLY IRREGULAR CAVITIES: AN APPLIED STUDY AND CONCEPTUAL DESIGN OF A 35 GHz GYROTRON Doctoral Thesis [GERACAO DE FEIXES DE ELETRONS EM MOVIMENTO CICLOTRONICO E SUA INTERACAO COM CAMPOS ELETROMAGNETICOS EM CAVIDADES FRACAMENTE IRREGULARES: UM ESTUDO APLICADO A ELABORACAO CONCEITUAL DE UM GIROTRON DE 35 GHZ]
Joaquim Jose BarrosodeCastro Dec. 1988 244 p In PORTUGUESE; ENGLISH summary
(INPE-4758-TDL/347) Avail: NTIS HC A11/MF A01

An investigation is presented for different phenomena that occur in a gyrotron: (1) generation and transport of helical electronbeams; (2) interaction of electrons in cyclotron motion with a transverse electric mode in resonant cavities operating near cutoff; and (3) electron deposition over the collector active region. An exact ballistic model, which points out the nonlinear attributes of the relativistic equation of electron cyclotron motion and that includes a complex formulation for the longitudinal electric field distribution in weakly irregular waveguides, is used. Physically realizable RF field profiles are studied with the objective of maximizing gyrotron efficiency. For this purpose, an investigation is made of the resonant properties of truncated cones cavities and a new resonator type, with a profile described in terms of a continuous function, is developed. High perpendicular efficiencies were calculated for interaction at the fundamental cyclotron harmonic and for uniform external magnetic field. A maximum efficiency scaling parameter S was introduced, by which scaling relations are applicable to a variety of field profiles. The conceptual design of a 35 GHz gyrotron gives emphasis to selection criteria of operating parameters in compliance with technical constraints and with the requirement of soft self-excited oscillations. The proposed gyrotron operates in the azimuthally symmetrical mode TE sub 021 and is able to produce, with an electronic efficiency of 40 percent an output power of 100 kW, in pulses of 20 ms, with a duty factor of 0.04 percent. Author

N89-26704 Technische Univ., Delft (Netherlands).
COULOMB INTERACTIONS IN PARTICLE BEAMS Ph.D. Thesis
Gerrit Hermanus Jansen 1988 477 p
(ETN-89-94885) Avail: Technische Univ., Delft, Guert Naber, Stevinweg 1, 2628 CN Delft, Netherlands

The theory of particle interactions in low and medium density, nonrelativistic, time-independent beams of identical particles, in probe forming instruments is discussed. Low and medium density and nonrelativistic refer to beam currents typically much smaller than 1 mA and beam voltages typically between 1 and 100 keV. Time-independent implies that the flow of particles is assumed to be constant. The theory is developed for electron-beam lithography pattern generators and scanning electron microscopes. It should be applicable to focused ion beam tools as well. The analytical models used are based on the ideas of Van Leeuwen and Jansen (1983). This work is extended and confronted with other theories and the results of numerical Monte Carlo simulation. The impact of particle interactions on beams in drift space is stressed. Results of an analysis to extend the model to beams in an external uniform acceleration field are presented. ESA

N89-26705# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
A STUDY OF THE BEAM-TARGET INTERACTIONS IN A STORAGE RING
N. Kalantar-Nayestanaki Jan. 1989 22 p
(NIKHEF-K/IT/89-01; ETN-89-94917) Avail: NTIS HC A03/MF A01

Two sets of calculations were performed for the proposed ring at NIKHEF-K. The first set is concerned with the emittance growth of the beam in the presence of an internal target. All calculations were done with a hydrogen target. The energy range of the electron beam is 300 tp 900 MeV. Simulations were performed for this investigation. For all the calculations, 1000 particles traversed the target 1 million times and the emittance growth rate was determined. The largest hydrogen target density that can be tolerated is 10 to the 17th atoms/cc. For lower energies, this limit is much smaller. In the second set of calculations electron beam loss mechanisms were investigated. It is shown that processes such as bremsstrahlung, single scattering, multiple scattering, and Moller scattering all contribute to the loss of electrons in the beam. Emittance growth imposes a density less than 10 to the 17th atoms/cc; for E0 = 900 MeV, beam lifetime is 30 sec. This means that after 30 sec, 63 pct of the electrons are lost and the beam has to dumped. For lower densities, the liftime is larger than 1 min so that lower energies can also be accommodated. Therefore, with the design parameters of the NIKHEF-K ring, long storage times are feasible with luminosities of up to 10(35)/cc/sec (corresponding to a target density of 10 to the 17th and a circulating current of 200 mA). For heavier nuclei, one has to use fewer atoms/cc to have the same lifetime for the beam. ESA

N89-26706# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands). Section Nuclear Physics.
THE VACUUM PROFILE OF THE ENERGY SPECTRUM COMPRESSOR
W. J. Kuijsten Dec. 1988 19 p
(NIKHEF-K/APS/88-10; MTG-22; ETN-89-94918) Avail: NTIS HC A03/MF A01

The pressure profile of the Energy Spectrum Compressor (ESC) vacuum line is considered. A finite element model of the vacuum system was developed to calculate the average pressure profile along the system in a fast way. It is important that the average pressure in the system does not influence the present performance of the linac, and that the pressure in the RF-cavities does not exceed 0.000001 Pa. Using standard ion-getter pumps pf 60 l/s it is shown that outgassing of the ESC system does not affect the pressure in the cavities of the linac and the pressure in the Beam Switch Yard. Pressure in the buncher section of the ESC can be kept in the 0.0000001 Pa range. To obtain this the pumps have to be placed on the first and the last curved-section, the collimator, the Secondary Emission Monitor and buncher section. An average pressure of less than 0.00001 Pa in the curved-sections can be obtained. ESA

74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers.*

N89-26707# Naval Research Lab., Washington, DC. Optical Sciences Div.
RADIATION RESPONSE PREDICTION OF SINGLE MODE FIBERS Final Report
E. J. Friebele, Charles G. Askins, Louise A. Brambani, Kenneth L. Dorsey, David L. Griscom, Michael E. Gingerich, Calvin C. Harrington, Cathy M. Shaw, Tsung-Ein Tsai, and Un-Chul Paek (American Telephone and Telegraph Co., Hopewell Junction, NJ.) Mar. 1988 247 p
(Contract MIPR-HC1001-6-40048)
(AD-A206211; NCS-TIB-88-1) Avail: NTIS HC A11/MF A01 CSCL 20/6

Fiber optic transmission systems, because of their extraordinary channel capacity and decreasing cost, are rapidly becoming the preferred terrestrial transmission media of the nation's long distance, inter-city telecommunications infrastructure. Since the commercial telephone network forms the foundation for emergency communication in the event of a national crisis or emergency, additional requirements are placed on the fibers and components being installed. One of the most stressing environments for the fiber consists of fallout subsequent to a nuclear attack. The susceptibility of some of types of commercially available fiber optic cable to optical darkening (and hence increased signal loss) from exposure to ionizing radiation raises serious questions about the survivability of such systems in the reconstitution phase of a nuclear conflict. There is a large body of knowledge available on the effects of gamma radiation on the older multimode fiber cables. However, there are critically important knowledge gaps with respect to the newer single mode cables which are employed in the inter-city fiber transmission links being installed today. This document is a final report of a two year program funded by NCS at NRL, which was the first systematic study of the interrelationship of fiber fabrication parameters and radiation-induced loss. A rudimentary regression model was developed for predicting the loss induced by a fallout exposure at -35 C. GRA

N89-26708 Department of the Air Force, Washington, DC.
FIBER OPTIC COHERENCE METER Patent
Joseph M. Geary, inventor (to AF) 31 May 1988 5 p Filed 26 Sep. 1986
(AD-D014005; US-Patent-4,747,688; US-Patent-Appl-SN-911935) Avail: US Patent and Trademark Office CSCL 20/6

An incident light field is applied to the two separate front fiber faces of a pair of identical optical fibers which are initially held in a common plane. One fiber face is always kept stationary. The other fiber face may be moved either laterally in a plane common to the stationary face or longitudinally into and out of the common plane. The output end of the device comprises two separate rear fiber faces that are held in a common plane. These faces are stationary. There is no lateral or longitudinal motion of one relative to the other. The light emerging from these two faces interferes in the far field. Straight line interference fringes whose spacing depends upon the lateral separation of the rear fiber faces are formed. The fringe modulation, however, depends upon the relative position of the front fiber faces. This modulation changes as one front face is scanned either laterally or longitudinally. The modulation changes with such motion are related to the degree of spatial or temporal coherence of the incident light field. GRA

N89-26709# Rockwell International Science Center, Thousand Oaks, CA.
FIBER OPTIC SENSOR SYSTEM Final Report, 30 May 1986 - 1 Jun. 1988
J. S. Schoenwald Mar. 1989 38 p
(Contract F04611-86-C-0036; AF Proj. 2864)
(AD-A206636; SC5463.FRD; AFAL-TR-88-102) Avail: NTIS HC A03/MF A01 CSCL 20/6

The design, development, and performance of a microbend fiber optical domain reflectometry (OTDR) based distributed strains sensor are described. A test bed has been developed to evaluate and compare this system to conventional discrete strain gauge sensors. The test bed consists of an aluminum cantilever beam to which have been attached several pairs of strain gauges (for reference) and several microbend transducers. A single standard multi-mode optical fiber is threaded through the microbend transducers. The fiber is pulse illuminated by a commercial OTDR instrument. The microbend losses are detected as step changes in the return OTDR signal waveform. The transducers consist of small pairs of opposing sets of teeth, one set mounted on the flexible beam test bed, the other machined into a small, rigid cantilever bar mounted to produce scissor action as the beam flexes. The transducers are biased to produce a step loss with the beam in its neural position. The direction of beam deformation is then determined by the increase or decrease of the step size. GRA

N89-26710# Chemical Dynamics Corp., Upper Marlboro, MD.
CALCULATION OF KINETIC DATA FOR PROCESSES LEADING TO UV SIGNATURES Final Report, 1 Aug. 1988 - 31 Jan. 1989
P. K. Swaminathan, G. A. Natanson, B. C. Garrett, and M. J. Redmon 31 Mar. 1989 56 p
(Contract F49620-88-C-0085; AF Proj. 3005)
(AD-A206656; AFOSR-89-0395TR) Avail: NTIS HC A04/MF A01 CSCL 21/2

Novel state-of-the-art computational techniques were developed and validated for studying collisional processes responsible for producing infrared and ultraviolet signatures in rocket plumes. The promising new methods involve computation of cross sections and rates within a semiclassical methodology. Two of the key beneficiary programs are the SPURC and the CHARM programs which require detailed microscopic dynamical information (kinetic rates and cross sections) about such collisional processes for successful modeling of the chemistry within appropriate flowfield simulation codes. Successful prediction and interpretation of ultraviolet signatures require treating collision induced transitions between different electronic states caused by the coupling between electronic and nuclear motions in molecules during collisions. Electronic transitions bring in inherently quantum mechanical effects that have no analogs in classical mechanics. The task of numerically solving the quantum mechanical equations of motion is still an unsolvable computational problem for many realistic molecular systems. The semiclassical theory is accurate enough to reproduce specific necessary quantum mechanical features, because it leads to ordinary differential equations instead of the partial differential equations of quantum mechanics. Electronic structure information required in modelling the production of candidate excited species, nitrogen, nitric oxide, and hydroxyl radical molecules in some elementary reactions was analyzed. GRA

N89-26711# Argonne National Lab., IL.
SOFT X-RAY UNDULATOR Annual Report, Dec. 1987 - Mar. 1989
Samuel D. Bader and Gopal K. Shenoy 15 Mar. 1989 27 p
(Contract N00014-87-F-0022)
(AD-A206721) Avail: NTIS HC A03/MF A01 CSCL 20/7

This is the second annual report for a two-year program to base a soft X-ray undulator at the vacuum ultraviolet (VUV) storage ring at the National Synchrontron Light Source (NSLS). The undulator will be used as a radiation source by multi-institutional research teams to perform the first spin-polarized photoemission experiments in the United States. The undulator source will permit major advances to take place in materials research in the forefront area of novel, ultra-thin magnetic films and surfaces. The two most important achievements are that contracts were negotiated both for the undulator and vacuum chamber that the undulator encases. Included is a timetable that shows the undulator installation on the NSLS VUV ring as taking place during the scheduled February, 1991 shutdown of the ring. The vacuum chamber is being fabricated by NSLS. Plans are underway at Argonne to design a methodology for testing the undulator

performance on the VUV ring. It will conclude monitoring the characteristics of the high-harmonic radiation output, because of its sensitivity to the magnetic design errors. Comparisons will be made to the performance of other insertion devices, with the hope that the data will permit future device design to benefit from past experience. GRA

N89-26712# OptiMetrics, Inc., Burlington, MA.
ALTERNATIVES TO MIE THEORY Technical Report, Oct. 1987 - Jun. 1988
David R. Longtin and Eric P. Shettle Jun. 1988 69 p
(Contract F19628-85-C-0178)
(AD-A206820; OMI-293; AFGL-TR-88-0154; SR-7) Avail: NTIS HC A04/MF A01 CSCL 20/6

This report examines how the scattering properties of spheres can be calculated without using Mie theory. Specifically, the scheme of ray optics is used to develop software that calculates the phase matrix elements of polydisperse spheres in geometrical optics limit. (Ray optics works well for size parameters greater than 400, and becomes more accurate for particles containing significant absorption.) In addition, this report examines a collection of numerical algorithms, developed by Nussenzveig and Wiscombe, that use complex angular momentum theory to obtain the efficiency factors for Mie scattering. Although accurate for size parameters greater than 20, it is shown that these algorithms are only computationally efficient for size parameters greater than 500. Finally, this report establishes regions of validity for other approximations to the Mie efficiency factors which exist in the scientific literature. It is shown that existing approximations can give reasonable estimates for the extinction efficiency for most size parameters and complex indices of refraction. On the otherhand, the approximations for the absorption efficiency are much less accurate. GRA

N89-26713# GTE Labs., Inc., Waltham, MA.
RADIATION HARDENED SILICA-BASED OPTICAL FIBERS Final Technical Report, Mar. 1985 - Dec. 1987
W. J. Miniscalco, T. Wei, and P. K. Onorato Dec. 1988 77 p
(Contract F19628-85-C-0050)
(AD-A206910; RADC-TR-88-279) Avail: NTIS HC A05/MF A01 CSCL 20/6

Since it is generally recognized that radiation-induced loss is due to pre-existing defects in optical fiber, the technical approaches were designed to reduce the number of these defects in as-drawn fiber and to passivate the ones that remain. While our investigations confirmed the Ge doping leads to greater sensitivity, both the experimental and theoretical results remain ambiguous as to whether fluorine is beneficial or deleterious. The diffusion of impurities from the preform substrate tube into the core has been identified as an important source of induced loss. Hydrogen treatment has been found to be an effective means of passivating defects in as-drawn fiber, and improved the hardness of most fibers tested. GRA

N89-26714# EIC, Inc., Newton, MA.
TUNABLE HIGH T, SUPERCONDUCTING INFRARED DETECTORS, PHASE 1 Final Report, Aug. 1988 - Feb. 1989
James D. Klein Feb. 1989 27 p
(Contract DAAH01-88-C-0745; ARPA Order-5916)
(AD-A206970; C-981F) Avail: NTIS HC A03/MF A01 CSCL 20/3

This program is aimed at the development of superconductor based infrared detector in which sensitivity is optimized through control over composition and microstructure. Cation composition and thin film morphology are to be determined precisely in the thin film deposition process. The superconducting thin film is to have an oriented polycrystalline microstructure to achieve Josephson junction behavior directly through the anisotropic superconducting properties of YBa2Cu3O7-x. The deposition substrate will be an oxygen ion conductor to permit continuous and controlled adjustment of the superconductor's oxygen stoichiometry. Since the properties of the new oxide superconductors are so dependent on the oxygen stoichiometry of the crystal lattice, such a device can be tuned for various operating conditions. GRA

N89-26715# Nebraska Univ., Lincoln. Dept. of Electrical Engineering.
FULL-WAVE COPOLARIZED NONSPECULAR TRANSMISSION AND REFLECTION SCATTERING MATRIX ELEMENTS FOR ROUGH SURFACES
Ezeliel Bahar and Mary Ann Fitzwater Nov. 1988 11 p Submitted for publication
(Contract DAAL03-87-K-0085)
(AD-A207050; ARO-25130.2-GS) Avail: NTIS HC A03/MF A01 CSCL 20/6

A 2 X 2 scattering matrix for rough surfaces that separate two different media is derived. To this end, explicit closed-form expressions for the nonspecular transmission scattering coefficients are derived for the rough-surface elements to complement previous derivations of the nonspecular reflection scattering coefficients. Both vertically and horizontally polarized electromagnetic excitations are considered here. Thus the elements of scattering matrices represent the polarization-dependent nonspecular transmission and reflection properties of each arbitrarily oriented and elevated element of the rough surface. The total nonspecularly transmitted and reflected fields are expressed as integrals (not integral equations). The full-wave solutions derived here are compared with the corresponding high-frequency physical optics results, and the low-frequency perturbation results are also derived. They are shown to satisfy the reciprocity and duality relationships in electromagnetic theory, and they are invariant to coordinate transformations. The results may be applied to both deterministic and random rough surfaces. GRA

N89-26716# Sea Tech, Inc., Corvallis, OR.
DEVELOPMENT OF AN OPTICAL FEEDBACK BASED HIGH ACCURACY BEAM TRANSMISSOMETER Progress Report
Robert Bartz 14 Feb. 1989 3 p
(Contract N00014-86-C-0784)
(AD-A207103) Avail: NTIS HC A02/MF A01 CSCL 09/5

Work concentrated on the fabrication of the optical bridge components, specifically the implementation of the proposed light source and detector assembly. Significant progress was made toward the development of a reliable package fabrication technique for the light source and detector assembly. The integrated light source assembly consisting of the header, Siemen's blue LED and reference detector was tested to determine if sufficient power output is available to obtain a signal to noise ratio of 60 DB. The reference detector current was 0.1 microamps at an LED current of 100 milliamps. This detector current is adequate to obtain the required signal to noise ratio but the LED current is higher than anticipated. The Cree blue LED is expected to solve this problem since it should have higher power output then a thermistor will be added to the integrated light source package to monitor the reference detector temperature allowing one to compensate for temperature allowing one to compensate for temperature effects. Most of the effort during this period was expended in trying to package the LED and reference detector. The potting of the integrated device posed some difficult problems which are hopefully solved. As always air bubbles were removed in a vacuum and the impurities problem was solved by using a centrifuge. GRA

N89-26717# Department of the Navy, Washington, DC.
OPTIC COMMUNICATION SYSTEM Patent Application
Louis Sica, inventor (to Navy) 5 Jan. 1989 16 p Filed 5 Jan. 1989
(AD-D014036; US-Patent-Appl-SN-293788) Avail: NTIS HC A03/MF A01 CSCL 25/3

An improved laser-driven, two way optic communication system for enabling communication between two atmospherically located and relatively spaced remote stations. The system is generally made up of a Transmitter-Receiver (TR) arrangement at one station and a Cooperative Transmitter-Receiver (CTR) arrangement at another station. The TR arrangement is generally made up of

laser source beam means, polarized means, polarized beam rotator means and appropriate lens means. The CTR arrangement is generally made up of appropriate lens means, beam splitter means and first and second Phase Conjugate Mirror (PCM) means. The PCM means are mounted on piezoelectric means that are selectively dithered so as to enable control of the return signal. The TR means causes propagation of a rotated laser source beam polarization output via the atmosphere to the CTR arrangement during system use. The CTR arrangement in response to the received laser beam from the TR provides transmission of combined/reflected and phase conjugated beams that are not subject to atmospheric turbulence so as to provide an enhanced two-way communication link with minimal light leakage between the CTR and TR. GRA

N89-26718# Rome Univ. (Italy). Dipartimento di Fisica.
BRILLOUIN SCATTERING INTENSITIES IN GLASSES: THEORY AND EXPERIMENT
V. Mazzacurati, M. Nardone, G. Ruocco, and G. Signorelli (Aquila Univ., Italy) 30 Sep. 1988 34 p Submitted for publication
(Preprint-627; ETN-89-94708) Avail: NTIS HC A03/MF A01

The interpretation of light scattering data in homogeneous disordered solids is reviewed on the basis of phenomenological theories. A microscopic fully electrodynamic theory which allows the calculation of Brillouin intensities is presented. A comparison is made with data on a number of glasses. It is suggested that the intensity of the depolarized longitudinal and transverse components contains relevant dynamical and structural information on these systems. ESA

N89-26719# Nationaal Inst. voor Kernfysica en Hoge Energiefysica, Amsterdam (Netherlands).
OPTICS OF THE AMSTERDAM PULSE STRETCHER PROJECT Status Report
R. Maas and Y. Y. Wu 1988 61 p
(NIKHEF-K/APS/88-11; ETN-89-94919) Avail: NTIS HC A04/MF A01

The Amsterdam electron accelerator pulse stretcher, storage ring, energy spectrum compressor, extraction line, and beam handling system are described. ESA

N89-26496*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MONOVISION TECHNIQUES FOR TELEROBOTS
P. W. Goode and K. Carnils *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 23-29 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 20F

N89-26504*# Perkin-Elmer Corp., Garden Grove, CA.
AN OPTICAL PROCESSOR FOR OBJECT RECOGNITION AND TRACKING
J. Sloan and S. Udomkesmalee *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 2 1 Jul. 1987 p 95-101 (For primary document see N89-26492 20-63)
Avail: NTIS HC A18/MF A01 CSCL 20F

75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

N89-26720*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
PLASMA DIAGNOSTICS PACKAGE. VOLUME 2: SPACELAB 2 SECTION. PART B: THESIS PROJECTS Final Science Report
Jolene S. Pickett, comp., L. A. Frank, comp., and W. S. Kurth, comp. Jun. 1988 725 p
(Contract NAS8-32807)
(NASA-CR-183699; NAS 1.26:183699) Avail: NTIS HC A99/MF E03 CSCL 20I

This volume (2), which consists of two parts (A and B), of the Plasma Diagnostics Package (PDP) Final Science Report contains a summary of all of the data reduction and scientific analyses which were performed using PDP data obtained on STS-51F as a part of the Spacelab 2 (SL-2) payload. This work was performed during the period of launch, July 29, 1985, through June 30, 1988. During this period the primary data reduction effort consisted of processing summary plots of the data received by 12 of the 14 instruments located on the PDP and submitting these data to the National Space Science Data Center (NSSDC). Three Master's and three Ph.D. theses were written using PDP instrumentation data. These theses are listed in Volume 2, Part B. K.C.D.

N89-26721*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
PLASMA DIAGNOSTICS PACKAGE. VOLUME 1: OSS-1 SECTION Final Science Report
Jolene S. Pickett, comp., L. A. Frank, comp., and W. S. Kurth, comp. Jun. 1988 234 p
(Contract NAS8-32807)
(NASA-CR-183697; NAS 1.26:183697) Avail: NTIS HC A11/MF A01 CSCL 20I

This volume (1) of the Plasma Diagnostics Package (PDP) final science report contains a summary of all of the data reduction and scientific analyses which were performed using PDP data obtained on STS-3 as a part of the Office of Space Science first payload (OSS-1). This work was performed during the period of launch, March 22, 1982, through June 30, 1983. During this period the primary data reduction effort consisted of processing summary plots of the data received by the 14 instruments located on the PDP and submitting these data to the National Space Science Data Center (NSSDC). The scientific analyses during the performance period consisted of general studies which incorporated the results of several of the PDP's instruments, detailed studies which concentrated on data from only one or two of the instruments, and joint studies of beam-plasma interactions with the OSS-1 Fast Pulse Electron Generator (FPEG) of the Vehicle Charging and Potential Investigation (VCAP). Internal reports, published papers and oral presentations which involve PDP/OSS-1 data are listed in Sections 3 and 4. A PDP/OSS-1 scientific results meeting was held at the University of Iowa on April 19-20, 1983. This meeting was attended by most of the PDP and VCAP investigators and provided a forum for discussing and comparing the various results, particularly with regard to the shuttle orbiter environment. One of the most important functional objectives of the PDP on OSS-1 was to characterize the orbiter environment. K.C.D.

N89-26722*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
PLASMA DIAGNOSTICS PACKAGE. VOLUME 2: SPACELAB 2 SECTION, PART A Final Science Report
Jolene S. Pickett, comp., L. A. Frank, comp., and W. S. Kurth, comp. Jun. 1988 488 p
(Contract NAS8-32807)
(NASA-CR-183698; NAS 1.26:183698) Avail: NTIS HC A21/MF A01 CSCL 20I

This volume (2), which consists of two parts (A and B), of the Plasma Diagnostics Package (PDP) Final Science Report contains a summary of all of the data reduction and scientific analyses which were performed using PDP data obtained on STS-51F as a part of the Spacelab 2 (SL-2) payload. This work was performed during the period of launch, July 29, 1985, through June 30, 1988. During this period the primary data reduction effort consisted of processing summary plots of the data received by 12 of the 14 instruments located on the PDP and submitting these data to the National Space Science Data Center (NSSDC). The scientific analyses during the performance period consisted of follow-up studies of shuttle orbiter environment and orbiter/ionosphere interactions and various plasma particle and wave studies which dealt with data taken when the PDP was on the Remote Manipulator System (RMS) arm and when the PDP was in free flight. Of

particular interest during the RMS operations and free flight were the orbiter wake studies and joint studies of beam/plasma interactions with the SL-2 Fast Pulse Electron Generator (FPEG) of the Vehicle Charging and Potential Investigation (VCAP). Internal reports, published papers and presentations which involve PDP/SL-2 data are listed in Sections 3 and 4. A PDP/SL-2 scientific results meeting was held at the University of Iowa on June 10, 1986. This meeting was attended by most of the PDP and VCAP investigators and provided a forum for discussing and comparing the various results, particularly with regard to the PDP free flight.
K.C.D.

N89-26723# National Aerospace Lab., Tokyo (Japan).
SPECTRAL CHARACTERISTICS OF ARC-HEATED LOW DENSITY PLASMA FLOWS (3) HELIUM PLASMA
Yasuo Watanabe and Noriaki Hirabayashi Feb. 1988 18 p In JAPANESE; ENGLISH summary
(NAL-TR-962; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

The spectral characteristics of helium plasma were examined in an arc-heated low density wind tunnel. He I lines in the plenum chamber showed large broadening and the profiles of 492 (2 1P-41D) and 447 (2 3P-43D) nm lines were recorded and compared with theoretical profiles of Barnard to yield electron densities. Electron densities were also estimated by the Inglis-Teller relation from the determination of merging quantum number of 2 3P-n3D series lines. These results were by several orders of magnitude larger than the values expected on the measured kinetic temperature and suggest large deviations from LTE (local thermodynamic equilibrium) state in the plenum chamber. Spectra excited in a low density supersonic test section flow were characterized by a strong emission of the N2(+) first negative system (FNS) in addition to six series of He I lines and He2 emissions. Vibrational population distributions of N2(+) FNS were measured and the excitation mechanism was discussed. Oxygen was added to the flow and the resulting spectra were identified as several O I lines and O2(+) FNS. It was suggested that the use of these O I lines might be helpful in flow characterization and surface chemistry studies in a simulation facility for atomic oxygen interactions with spacecraft surfaces in low earth orbit.
Author

N89-26724# Nagoya Univ. (Japan).
RESISTIVITY OF FLAME PLASMA IN AN ELECTRIC FIELD
Kazunari Ikuta Jan. 1989 13 p
(IPPJ-897; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

A generalized Ohm's law is obtained for a flame plasma in an electric field for the study of arc resistivity in an electromagnetic launcher (EML). The effective resistivity of flame plasma is reduced by the source, which suggests the injection of premixed combustible fuel into the arc plasma in EML in order to reduce the electron energy of the arc. The reduction of electron energy in the arc is desirable to minimize the damage of electrodes in EML. Author

N89-26725# Nagoya Univ. (Japan). Inst. of Plasma Physics.
SECONDARY ELECTRON EMISSION FROM A METAL SURFACE BOMBARDED BY SLOW MULTIPLY CHARGED IONS
S. Ohtani, K. Oda, A. Ichimiya, S. Takagi (Toho Univ., Tokyo, Japan), H. Tawara, and Y. Yasue 7 Dec. 1988 21 p
(IPPJ-895; ISSN-0469-4732) Avail: NTIS HC A03/MF A01

Pulse height distributions of a microchannel plate (MCP) for impact of slow multiply charged ions were measured. It was observed that a relative gain of the MCP increases with an increase of the charge state of incident ions. Such gain characteristics are discussed in connection with secondary electron emission yield at the input of the MCP. Next, absolute values of electron emission yield gamma for impact of Ar(q+) (q=1-8) on a polycrystalline tantalum and gold surface were measured. The values of gamma are nearly proportional to the total potential (neutralization) energy of the incident ions. Author

N89-26726*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
THEORY OF THE PULSE RESPONSE FROM A SMALL ANTENNA IN A MAGNETIZED PLASMA
Crockett L. Grabbe [1989] 19 p
(Grants NAGw-364; NAGw-827; NSF ATM-83-12514)
(NASA-CR-185454; NAS 1.26:185454) Avail: NTIS HC A03/MF A01 CSCL 20I

The electrostatic plasma response to a small pulsed antenna in a magnetic field is analyzed. The ringing of the plasma at three discrete frequencies--the upper-hybrid frequency and two resonance cone branch frequencies--is evidenced, and the amplitudes of these frequency responses is determined as a function of the characteristic plasma frequencies, the angle of observation with respect to the magnetic field, and the pulse length. Applications to plasma diagnostics are discussed. It is shown that the upper hybrid response and the response at either of the resonance cone branch frequencies is adequate information to determine the plasma density, and the magnetic field magnitude and angle. Author

N89-26727*# Iowa Univ., Iowa City. Dept. of Physics and Astronomy.
AURORAL PLASMA WAVES
Donald A. Gurnett Jan. 1989 61 p Presented at the International Conference on Auroral Physics, Cambridge, England, 11-15 Jul. 1988
(Grants NAG5-310; NAG5-1093; NAGw-1488)
(NASA-CR-185449; NAS 1.26:185449; U-of-Iowa-89-11) Avail: NTIS HC A04/MF A01 CSCL 20I

A review is given of auroral plasma wave phenomena, starting with the earliest ground-based observations and ending with the most recent satellite observations. Two types of waves are considered, electromagnetic and electrostatic. Electromagnetic waves include auroral kilometric radiation, auroral hiss, ELF noise bands, and low-frequency electric and magnetic noise. Electrostatic waves include upper hybrid resonance emissions, electron cyclotron waves, lower hybrid waves, ion cyclotron waves and broadband electrostatic noise. In each case, a brief overview is given describing the observations, the origin of the instability, and the role of the waves in the physics of the auroral acceleration region. Author

N89-26728# Cornell Univ., Ithaca, NY. Lab. of Plasma Studies.
INTENSE ION BEAM GENERATION, PLASMA RADIATION SOURCE AND PLASMA OPENING SWITCH RESEARCH Final Report, 1 Jan. - 31 Dec. 1988
D. A. Hammer, M. D. Coleman, N. Qi, P. L. Similon, and R. N. Sudan Apr. 1989 43 p
(Contract N00014-88-K-2009)
(AD-A206848; LPS-FR88ONR-1) Avail: NTIS HC A03/MF A01 CSCL 20/9

This report describes research on intense ion beam diodes, plasma opening switches and dense z-pinch plasma radiators. Laser induced fluorescence spectroscopy has been used to map the electrostatic potential profile in a plasma-prefilled magnetically insulated ion diode. In a simple planar diode, the measured profile is inconsistent with the electrons being confined in a sheath near the cathode by the magnetic field. Rather, the profile implies the presence of electrons throughout the accelerating gap. A theoretical model of the penetration of current and magnetic field into a plasma, and of the current-driven effective collision frequency has been developed. The snowplow action of the rising magnetic field causes a steep rise in the plasma density at the leading edge. The subsequent multistreaming of the ions caused by ion reflection at the current layer could lead to ion heating through collective effects. The two-dimensional electron flow in the plasma cathode vacuum gap is also treated. Dense z-pinch plasma radiation source experiments have been initiated on the LION accelerator using gas puff and fine wire loads. The x-pinch was found to be a more effective way to generate soft x-rays than a single wire pinch or a gas puff implosion. Plasma opening switch experiments being

initiated, and plasma anode ion diode development work being terminated are also briefly described. GRA

N89-26729# Maryland Univ., College Park. Lab. for Plasma and Fusion Energy Studies.
QUANTITATIVE SPECTROSCOPY OF X-RAY LASER PLASMAS IN PULSED POWER Annual Progress Report, Apr. 1988 - Mar. 1989
Mar. 1989 3 p
(Contract N00014-87-K-2019)
(AD-A206908) Avail: NTIS HC A02/MF A01 CSCL 20/9

At the start of the reporting period indicated above the original Z -pinch setup was in place and running. Diagnostics consisting of a framing camera, 1 m N.I. VUV spectrometer, 1/2 m visible spectrometer and a Rogowski coil had been set up and were functional. To begin, with a framing camera a study of the visible signature of the plasma for a variety of different conditions (e.g., gas voltage in discharge, etc.) was conducted. This gave a working understanding of the gross behavior of the discharge. The emphasis was shifted to obtaining a temporal sequence of time resolved photographic spectra which would include the 5f-3d and 4f-3d transitions in CIV, the lines of primary interest for this experiment. Preliminary steps, such as checking the calibration of the 1 m VUV spectrometer/MCP/photographic film with an Ar capillary discharge lamp, and the location of optimal discharge conditions/MCP pulse parameters/photographic film development procedures, were conducted. GRA

N89-26730# Air Force Astronautics Lab., Edwards AFB, CA.
THERMONUCLEAR REACTION BIBLIOGRAPHY WITH CROSS SECTION DATA FOR FOUR ADVANCED REACTIONS Interim Report, Jun. 1988 - Jan. 1989
Larry T. Cox, Jr. Mar. 1989 35 p
(AD-A206915; AFAL-TR-89-006) Avail: NTIS HC A03/MF A01 CSCL 20/8

The feasibility is being explored for fusion-powered propulsion. This report builds on a bibliography of all known thermonuclear reactions involving reactant particles up to and including B11 (Boron-11). However, in the report presented here, the neutron-induced reactions have been eliminated. A few reactions which are new to the earlier report have been found and are included. This report will form the basis for future reports generated from this study. In these future reports, fuel cycles, reaction rates, nuclear scattering, and ignition temperatures will be addressed. Included in this interim report are cross section data for four of the more attractive, in terms of safety, reactions. Graphs showing the data are also presented herein, including one which compares the cross section data curves of the four reactions. All of the data sets are analyzed and recommendations for future cross section work are made. GRA

N89-26731# Tennessee Univ., Knoxville. Plasma Science Lab.
INVESTIGATION OF RF EMISSIONS FROM ELECTRIC FIELD DOMINATED PLASMAS Final Scientific Report, 31 Jan. 1980 - 31 Mar. 1989
J. Reece Roth 31 Mar. 1989 468 p
(Contracts N00014-88-K-0174; N00014-80-C-0063)
(AD-A207017; UTK-PSL-89-1) Avail: NTIS HC A20/MF A01 CSCL 20/9

Research include the effort to confirm the theory of the geometric mean plasma emission. This process results from two interpenetrating electron beams in a Penning discharge. Efforts were made on diagnostic and software development for the study of plasma turbulence, automatic reduction of Langmuir probe data, and correlation studies of plasma fluctuations and turbulence using digital time series analysis techniques based on the fast Fourier transform. The methods of chaos theory are applied to the investigation of plasma turbulence, using a commercially available software program. Extensive studies were conducted of fluctuations in the highly turbulent Penning discharge. By perturbing the plasma with a signal of known amplitude and frequency applied to an effector probe, enhancement of plasma turbulence and the resulting turbulent heating of the plasma electron and/or ion population were demonstrated. These active modification experiments also demonstrated conditions under which a low frequency modulation of the plasma by the effector probe could dampen the turbulent modes present in the unmodulated plasma. The damping of turbulent modes at higher frequencies, above 50 kilohertz, was as high as 10 to 20 db in some instances. This suggests a way to actively modify plasma turbulence and affect or reduce transport parameters which depend on the level of plasma turbulence. GRA

N89-26732# West Virginia Univ., Morgantown. Dept. of Mathematics.
PROBLEMS IN DYNAMIC PHASE TRANSITION Final Report, 1 Sep. 1987 - 30 Sep. 1988
Harumi Hattori 18 Nov. 1988 6 p
(Grant AF-AFOSR-0347-87; AF Proj. 2304)
(AD-A207027; AFOSR-89-0376TR) Avail: NTIS HC A02/MF A01 CSCL 20/9

This paper, on the existence of intermediate magnetohydrodynamic shock waves; has used the technique called the connection matrix to establish one of the intermediate shocks which was not shown to exist. There are a few approaches to the phase transition problem. One is to consider the momentum equation and another one is to consider the energy equation. GRA

N89-26733# Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
SPECTROSCOPIC DIAGNOSTICS OF ELECTRON TEMPERATURE AND ENERGY CONVERSION EFFICIENCY OF LASER-SUSTAINED PLASMA IN FLOWING ARGON Report, 1 Sep. 1987 - 8 Aug. 1988
J. Mazumder, H. Krier, and X. Chen 25 Aug. 1988 91 p
(Grants AF-AFOSR-0169-87; AF-AFOSR-0129-88; AF Proj. 2308)
(AD-A207054; UILU-ENG-88-4014; AFOSR-89-0442TR) Avail: NTIS HC A05/MF A01 CSCL 07/4

Laser sustained plasmas are often formed during laser materials interaction. The University's 10 kW CW CO2 laser has been used to study argon plasmas for the application to laser supported propulsion and laser materials processing. The spectroscopic diagnostic method has been applied to study laser-sustained plasmas in 1 atmosphere pure argon gas flow with an f/7 on-axis laser focusing scheme. High flow speeds of 2 to 10 m/sec are achieved. Plasma electron temperatures distributions are determined from the 415.8 nm Ar1 line and its adjacent continuum intensities. Plasma core temperatures as high as 20,000 K are reported. The total absorption of the incident laser power and the radiation loss by the plasma are calculated from the temperature distribution. Results indicated that up to 86 percent of the incident laser power can be absorbed and nearly 60 percent of the incident laser power can be retained by the flowing argon gas to provide thrust. Further research is called for in the Laser Induced Fluorescence (LIF) technique for diagnostics of the downstream mixing zone and the plasma outer region. Experiments over a wider range of operating conditions, as well as multiple plasma testings, are required to find the optimum operating scheme. GRA

N89-26734# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
CHARACTERIZATION OF PLASMA IN MAGNETIC MULTIDIPOLE DISCHARGES M.S. Thesis [CARACTERIZACAO DO PLASMA EM DESCARGAS MULTIDIPOLO MAGNETICAS]
Julio GuimaraesFerreira Sep. 1988 223 p In PORTUGUESE; ENGLISH summary
(INPE-4704-TDL/343) Avail: NTIS HC A10/MF A01

A characterization of the discharge of the quiescent plasma machine of INPE, and an identification of the most relevant processes in the definition of its plasma properties, were achieved. Measurements of plasma potential, the floating potential, the temperature of the electrons, and the density of the plasma, for pressures ranging from 10(-3) to 10(-1) Pa and for discharge potentials for 45 V to 120 V were accomplished. These

measurements were made with a Langmuir spherical probe with 1mm in diameter. In the whole range of operation the presence of two populations of electrons with distinct temperatures in the energy range from 1 to 10 eV was observed, although for pressures approaching 10(-1) Pa the plasma tended to a single population of electrons with temperature of 1eV. The difference between plasma and floating potentials was observed to become smaller as the pressure raised, and the potential difference between plasma and anode reached a value around 2 V when pressure raised above 10(-2) Pa. The plasma density increases approximately linearly with pressure, for values below 10(-2) Pa, but above 10(-1) Pa its increase with pressure is quite reduced. A study on the collision processes in the plasma volume and on loss processes to surfaces allowed to interpret qualitatively the observed plasma behavior and to estimate, by means of simple expressions, some of the plasma parameters. The loss areas for ions and primary electrons were estimated from experimental results. A simple quantitative model which allows the calculation of plasma density in the whole range of operation, reproduced the correct order of magnitude of experimental values. However, an additional work, both theoretical and experimental, is required to obtain better agreement between experimental and theoretical values. Author

N89-26735# Technische Univ., Eindhoven (Netherlands).
ON THE ELECTRIC AND MAGNETIC FIELD GENERATION IN EXPANDING PLASMAS Ph.D. Thesis
Herman Johannes Gert Gielen 1989 196 p
(ETN-89-94874) Avail: NTIS HC A09/MF A01

A general method that decomposes each of the forces terms in Ohm's law in a component that induces a charge separation in the plasma and a component that can drive current is given. This decomposition is unambiguous and depends on the boundary conditions for the electric potential. It is shown that in calculating the electromagnetic field quantities in a plasma that is located in the vicinity of a boundary that imposes constraints on the electric potential. Ohm's law should be analyzed instead of the so-called induction equation. Experiments on a magnetized argon plasma expanding from a cascaded arc are described. Spectrometric techniques were used to determine the electron density, ion temperature, and the rotation velocity profiles of the ion gas. Using the Zeeman effect, the magnetic field generated by the plasma was measured. Depending on the channel diameter of the nozzle of the cascaded arc, self-generated magnetic fields with axial components of the order of 1 percent of the externally applied magnetic field are observed. From the measured ion rotation it is concluded that this self-generated magnetic field is mainly generated by azimuthal electron currents. The corresponding azimuthal current density is of the order of 15 percent of the axial current density. The observed ion rotation is a consequence of the electron-ion friction. ESA

76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

N89-26736# Polish Academy of Sciences, Warsaw. Inst. Podstawowych Problemow Techniki.
PARAMETERS OF SAW FOR TECHNICALLY IMPORTANT PIEZOELECTRICS
Eugeniusz Danicki and Teresa Czerwinska 1988 88 p In POLISH; ENGLISH summary
(ISSN-0208-5658) Avail: NTIS HC A05/MF A01

The results of computations of acoustic fields of surface acoustic waves (SAW) propagating in some piezoelectric materials, are presented for given Euler angles. The diagonal elements of a matrix of effective surface admittance are also presented. The results are given in graphic form as functions of a wave-number of surface forces. All quantities are presented in the SI system for angular frequency of a wave equal to 1/s. A numerical program in FORTRAN is included. Author

N89-26737# Aerospace Corp., El Segundo, CA. Chemistry and Physics Lab.
THIN-SOURCE CONCENTRATION-DEPENDENT DIFFUSION: A FULL SOLUTION
Genghmun Eng 19 Jun. 1988 43 p
(Contracts DE-AC02-76ER-01198; F04701-85-C-0086)
(Aerospace-ATR-86A(8573)-1) Avail: NTIS HC A03/MF A01

A method of analysis is developed for solving the problem of an initially thin source of impurity ions diffusing into a host solid, when the mechanism of transport involves a concentration-dependent diffusivity. In order to extract a diffusivity from experimental data, it is shown that the fundamental experiment required is a measurement of the diffusion profile at two different times. The constant and the concentration-dependent contributions to the diffusivity then can be isolated by requiring the initial measured profile to propagate into the final measured profile. The analytic procedure presented here is shown to be a full solution to the problem of a diffusivity that varies linearly with concentration: D(C) = D sub o(1 = alphs C), where alpha is the strength of the nonlinear term. A matrix of orthogonal functions determines the time evolution for an arbitrary thin-source initial state. It is shown that the total diffusant amount is conserved, and the solution is naturally expressed as a power series in alpha. The persistence of curvature on (1n(C) vs x squared) axes is then derived from the asymptotic (long-time) properties of the nonlinear equation solution. The solution up through order alpha squared is then explicitly constructed for an arbitrary thin-source initial state. Author

N89-26738# Science Applications International Corp., San Diego, CA. Foreign Applied Sciences Assessment Center.
RECENT SOVIET MICROELECTRONICS RESEARCH ON III-V COMPOUNDS SEMICONDUCTORS
H. Sello and C. G. Kirkpatrick Aug. 1988 166 p
(FASAC-TAR-4030) Avail: NTIS HC A08/MF A01

The activity in the Soviet Union on III-V compound semiconductor devices during the past five years is examined in the areas of materials, processes, radiation effects, and devices by a search of the translated technical journals. The majority of the work in III-V materials is concerned with gallium arsenide (GaAs), and the materials are certainly of the quality needed to make integrated circuits (ICs). However, the focus of Soviet growth and characterization studies appears to be basic materials properties, rather than development of capabilities and understanding for making integrated circuits. In processing, the Soviets appear to have very little effort on metaloorganic chemical vapor deposition on III-V compounds, while this is the process of choice in the West. There is, however, a substantial effort on X-ray lithography for silicon that could be extended to GaAs. High-quality work is also reported for ion beam, electron beam, optical projection, and laser processing silicon. Research on metallization (interconnection) and dielectric deposition processes for GaAs is absent. Soviet research on ion implantation and laser annealing in compound semiconductors is largely directed toward basic phenomena, such as defect information, rather than on electrical characteristics considered important for integrated circuit fabrication. Outstanding basic work is also being conducted on the radiation effects of electrons, protons, alpha, gamma, and X-rays on materials. These Soviet studies of radiation effects do not appear to be directed toward the fabrication of actual devices. Soviet GaAs device work appears to be generally of a theoretical nature, relying in part on device data obtained from Western articles. The most advanced involves the junction field effect transistor and heterojunction bipolar transistor, with little work reported on the fabrication of GaAs integrated circuits. Author

N89-26739*# Michigan Univ., Ann Arbor. Solid State Electronics Lab.
MOLECULAR BEAM EPITAXIAL GROWTH OF HIGH-QUALITY InSb ON InP AND GaAs SUBSTRATES
J. E. Oh, P. K. Bhattacharya, Y. C. Chen, and S. Tsukamoto [1989] 17 p

(Grants NAG3-988; NSF ECSE-88-00659)
(NASA-CR-185440; NAS 1.26:185440) Avail: NTIS HC A03/MF A01 CSCL 20L

Epitaxial layers of InSb were grown on InP and GaAs substrates by molecular beam epitaxy. The dependence of the epilayer quality on flux ratio, J sub Sb4/J sub In, was studied. Deviation from an optimum value of J sub Sb4/J sub In (approx. 2) during growth led to deterioration in the surface morphology and the electrical and crystalline qualities of the films. Room temperature electron mobilities as high as 70,000 and 53,000 sq cm /V-s were measured in InSb layers grown on InP and GaAs substrates, respectively. Unlike the previous results, the conductivity in these films is n-type even at T = 13 K, and no degradation of the electron mobility due to the high density of dislocations was observed. The measured electron mobilities (and carrier concentrations) at 77 K in InSb layers grown on InP and GaAs substrates are 110,000 sq cm/V-s (3 x 10(15) cm(-3)) and 55,000 sq cm/V-s (4.95 x 10(15) cm(-3)), respectively, suggesting their application to electronic devices at cryogenic temperatures. Author

N89-26740*# Michigan Univ., Ann Arbor. Solid State Electronics Lab.
SURFACE MORPHOLOGIES AND ELECTRICAL PROPERTIES OF MOLECULAR BEAM EPITAXIAL InSb AND InAs(x)Sb(1-x) GROWN ON GaAs AND InP SUBSTRATES
J. E. Oh, Y. C. Chen, P. K. Bhattacharya, and S. Tsukamoto [1989] 19 p Sponsored by NSF and NASA, Langley Research Center, Hampton, VA
(Grant NAG3-988)
(NASA-CR-185439; NAS 1.26:185439) Avail: NTIS HC A03/MF A01 CSCL 20L

Surface morphologies and electrical properties of molecular beam epitaxial InSb and InAs(x)Sb(1-x) grown on GaAs and InP substrates are discussed. The crystals are all n-type at 300 K and lower temperatures. The surface morphology and electrical characteristics are strongly dependent on Sb(4)/In flux ratio and substrate temperature. The highest mobilities in InSb on InP are 70,000 at 300 K and 110,000 cm(2)/V.s (n=3x10(15) cm(-3)) at 77 K. The mobilities in the alloys also increase monotonically with lowering of temperature. Good quality InAs(x)Sb(1-x) was grown directly on InP substrates by molecular beam epitaxy. K.C.D.

N89-26741*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DEVELOPMENT OF NEW TECHNIQUES FOR THE CHARACTERIZATION OF CRYSTALS AND THEIR GROWTH SOLUTIONS: CENTER DIRECTOR'S DISCRETIONARY FUND Final Report
Roger L. Kroes and Donald A. Reiss Jun. 1989 21 p
(NASA-TM-100371; NAS 1.15:100371) Avail: NTIS HC A03/MF A01 CSCL 20L

The solubility measurement system and the laser scattering microscope system were designed, built, and utilized for the study of crystal growth solutions and crystal characterization measurements. Solubility measurements and crystal defect maps were made with this equipment for a number of new materials. In some cases, where there have been published solubility data (i.e., TGS), more accurate measurements were made and discrepancies in the published data were resolved. The design of these instruments is presented along with a description of their use and some typical data generated using them. Author

N89-26742# Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering and Computer Science.
CHEMICAL BEAM EPITAXY OF ZnSe Semiannual Report, 1 Aug. 1988 - 31 Jan. 1989
Leslie A. Kolodziejski Apr. 1989 6 p
(Contract N00014-88-K-0564)
(AD-A206635) Avail: NTIS HC A02/MF A01 CSCL 07/2

The objective of the program is to determine optimum growth parameters for the chemical beam epitaxy of ZnSe. In addition microstructural, optical, and electrical characterization of the material will be performed to assess the material's quality and potential. Comparisons will be made with material grown by molecular beam epitaxy. GRA

N89-26743# State Univ. of New York, Buffalo. Dept. of Chemistry.
LIGHT SCATTERING FROM AN ATOM NEAR THE SURFACE OF A SUPERLATTICE
Xiao-shen Li, D. L. Lin, and Thomas F. George Apr. 1989 26 p
(Contract N00014-86-K-0043)
(AD-A206670; UBUFFALO/DC/89/TR-96) Avail: NTIS HC A03/MF A01 CSCL 20/5

A semiclassical theory is developed to treat the interaction of radiation with an atom located near the surface of an m-component superlattice. For the special case of m = 2, the radiation penetration depth into the superlattice and the resonance fluorescence spectrum are calculated numerically for superlattices of metal-insulator construction. The results show sensitive dependence on the plasma frequency in the metal layer as well as on the dielectric function and width of the insulator layer. GRA

N89-26744# University of Southern California, Los Angeles. Dept. of Chemistry.
STATE TO STATE COLLISION INDUCED DISSOCIATION AND GAS/SURFACE INTERACTIONS Final Report, Oct. 1985 - Oct. 1988
Curt Wittig and Hanna Reisler 1 Mar. 1989 19 p
(Contract F49620-86-C-0004)
(AD-A206676; AFOSR-89-0383TR) Avail: NTIS HC A03/MF A01 CSCL 07/2

The main thrust of our contract was directed towards the study of gas surface interactions and the complementary collisionless photodissociation processes. The initial experiments were concerned with NO scattering from an insulating MgO(100) single crystal surfaces, and the preliminary results were published in Chem. Phys. Lett. Experiments are being conducted in which molecules with high kinetic energy are dissociated and/or ionized upon impact on surfaces. The preliminary results, which are first of their kind since they involve state-resolved detection of the dissociation products, were accepted as a Communication in the Journal of Chemical Physics. In parallel with these new experiments, studies were continued in the photophysics and photodissociation dynamics of molecules which are suitable candidates for the beam/surface and beam/beam experiments. These include detailed studies of the photodissociation dynamics of such molecules as nitrosyl cyanide, nitrosyl chloride, t-BuNO and n- and iso-nitrosopropane. GRA

N89-26745# Westinghouse Research and Development Center, Pittsburgh, PA. Superconductor Materials and Electronics.
SUPERCONDUCTING OXIDE FILMS FOR MULTISPECTRAL INFRARED SENSORS Final Report, 1 Jan. - 31 Dec. 1988
A. I. Braginski, M. G. Forrester, M. Gottlieb, J. Talvacchio, and J. R. Gavaler 7 Feb. 1989 43 p
(Contract F49620-88-C-0030; AF Proj. 0812)
(AD-A206685; Rept-89-9S52-INFSC-R1; AFOSR-89-0385TR)
Avail: NTIS HC A03/MF A01 CSCL 20/3

Optical detection was investigated in epitaxial and granular films of YBa2Cu3O7-delta, at wavelenths of 0.63, 3.39, and 10.6 micrometers, at temperatures from 4.2K to 100K. Epitaxial films, and granular films fabricated at Westinghouse, exhibit an optically-induced voltage shift (delta V) which is proportional to the temperature derivative of the sample dc resistance at the same bias current. Granular films provided by the University of Texas, which exhibit semiconducting resistive behavior, exhibit a response which deviates from dR/dT, but which can be explained in terms of the temperature dependence of the film thermal conductance. The response time of all films is long and strongly wavelength dependent, varying from of order microseconds at 0.63 micrometers to tenths of a second at 3.39 micrometers. Results

indicate that all these films exhibit only bolometric or thermal detection, with no evidence for quantum or non-equilibrium effects in this temperature range. GRA

N89-26746# Claremont Graduate School, CA. Dept. of Mathematics.
THREE-DIMENSIONAL MODELLING FOR CONTACT RESISTANCE OF CURRENT FLOW INTO A SOURCE/DRAIN REGION Final Report, 1 Jun. 1987 - 31 May 1988
Ellis Cumberbatch and Weifu Fang 31 May 1988 35 p
(Grant AF-AFOSR-0222-87; AF Proj. 2304)
(AD-A206694; AFOSR-89-0433TR) Avail: NTIS HC A03/MF A01 CSCL 09/1

Various extensions of the transmission line model are introduced to find the resistance for current flow in MOSFET source/drain regions. The geometry is taken to be a rectangular box with a rectangular contact on the upper surface. Explicit formula are derived by assuming that the current flow is restricted to various geometrical planes. Comparison of basic results with simulation and experimental data is good. Comparison with simulation results for misalignment is less good. GRA

N89-26747# Aerospace Corp., El Segundo, CA. Chemistry and Physics Lab.
SUBSURFACE DAMAGE PROFILING SYSTEM FOR SEMICONDUCTOR MATERIAL
Neil A. Ives and Martin S. Leung 1 Mar. 1989 22 p
(Contract F04701-85-C-0086)
(AD-A206793; TR-0088(3945-09)-1; SD-TR-89-11) Avail: NTIS HC A03/MF A01 CSCL 09/1

Subsurface damage in polished GaAs wafers has been identified by electron microscopy and other surface analytical techniques. Subsurface damage can adversely affect the performance and reliability of devices fabricated on such substrates. In this report, we introduce a method for determining the degree of subsurface damage as a function of depth. Interferometry is used to measure the rate at which substrate material is being etched from the sample. Measuring the etch rate as a function of depth reveals the profile of subsurface damage in the sample. We describe the methodology and present our findings on GaAs wafers that have been subjected to surface damage. Samples obtained from different wafer manufacturers were investigated. GRA

N89-26748# Rome Air Development Center, Griffiss AFB, NY.
PREPARATION OF THE SUPERCONDUCTOR SUBSTRATE: STRONTIUM TITANATE Final Report
Kenneth P. Quinlan, Robert M. Hilton, and Joseph A. Adamski Sep. 1988 18 p
(AD-A206800; RADC-TR-88-216) Avail: NTIS HC A03/MF A01 CSCL 11/6

Preparation of the superconductor substrate, strontium titanate, is described. Procedures used to prepare the substrates for the strontium titanate boules are detailed. The strontium titanate crystals are grown using an oxidizing flame (hydrogen to oxygen ratio of 1). The other parameters used for crystals growth are reported. The growth direction was determined to be 5 degrees away from the (211) direction. ICP-emission spectroscopy indicates that the burner material may contribute a small number of impurities to the crystals. GRA

N89-26749# Oregon State Univ., Corvallis. Dept. of Electrical and Computer Engineering.
POINT DEFECTS IN SEMICONDUCTORS: MICROSCOPIC IDENTIFICATION, METASTABLE PROPERTIES, DEFECT MIGRATION AND DIFFUSION Final Technical Report, 31 Aug. 1986 - 31 Mar. 1989
James A. VanVechten and John F. Wager 31 Mar. 1989 135 p
(Grant AF-AFOSR-0309-86; AF Proj. 2306)
(AD-A206947; AFOSR-89-0402TR) Avail: NTIS HC A07/MF A01 CSCL 09/1

The goal of the research program described herein was to provide insight into the identity and properties of point defects in semiconductors. Particular emphasis was devoted to problems involving microscopic identification, metastable properties, defect migration, and diffusion of point defects in semiconductors. Our approach was to apply atomistic thermodynamic theory, Monte Carlo simulation, and experimental analysis to elucidate the nature and properties of semiconductor defects. Significant progress has been made in the following seven areas: (1) recombination enhanced vacancy migration in silicon, (2) Monte Carlo simulation of diffusion in semiconductors, (3) phosphorous vacancy nearest-neighbor hopping in InP, (4) entropy of migration for atomic hopping, (5) EL2/EL0 identification in GaAs, (6) characterization and identification of DX in A1GaAs, and (7) temperature dependence of band offsets. GRA

N89-26750# Chemical Dynamics Corp., Upper Marlboro, MD.
GROWTH STUDIES OF METAL-METAL/SEMICONDUCTOR STRUCTURES Final Report, 1 Aug. 1988 - 31 Jan. 1989
C. S. Murthy, B. M. Rice, and M. J. Redmon 31 Mar. 1989 46 p
(Contract F49620-88-C-0086)
(AD-A206988; AFOSR-89-0461TR) Avail: NTIS HC A03/MF A01 CSCL 07/2

The overall goal of the research program is to develop an atomistic approach to gain an understanding of the mechanisms of growth processes and to contribute to the development of metal metal and metal semiconductor heterostructures. The Phase 1 research involved reliable modelling of underlying atomic interactions within the atomic constituents of the substrate, interface, and adlayer; and static and dynamical studies of interfacial energetics and kinetics. A survey of available schemes has been made and a strategy for our own future modelling efforts is identified. GRA

N89-26751# Naval Research Lab., Washington, DC. Solid State Devices Branch.
DENSITY-GRADIENT THEORY OF ELECTRON TRANSPORT IN SEMICONDUCTORS
M. G. Ancona and H. F. Tiersten (Rensselaer Polytechnic Inst., Troy, NY.) 22 Mar. 1989 31 p
(AD-A206995; NRL-MR-6444) Avail: NTIS HC A03/MF A01 CSCL 07/4

A macroscopic description of electron transport in semiconductors was recently developed (M. G. Ancona and H. F. Tiersten, Phys. Rev. B35-II, 7959 (1987)) in which the equation of state of the electron gas was generalized to permit a dependence on the gradient of the gas density. This generalization leads to a macroscopic theory - density-gradient theory - which is often expressible as a generalized diffusion-drift description and which is capable of describing quantum transport phenomena associated with carrier confinement and tunneling. The original paper contained a derivation of this description from well known principles of classical field theory but only in a very condensed form. It is the purpose of the present report to supplement the earlier paper by giving the detailed derivations. As in the original paper two methods of derivation are presented: One is a variational approach which follows the work of Toupin while the other uses a balance law approach pioneered by Green and Rivlin. GRA

N89-26752# General Electric Co., Syracuse, NY. Electronics Lab.
PSEUDOMORPHIC In(x)Ga(1-x)As MATERIALS Annual Report, 1 Mar. 1988 - 30 Mar. 1989
James M. Ballingall, P. Ho, and T. Yu Martin 31 Mar. 1989 24 p
(Contract F49620-88-C-0054)
(AD-A207037; AFOSR-89-0463TR) Avail: NTIS HC A03/MF A01 CSCL 07/2

The objective of this program is to evaluate the dependence of pseudomorphic InxGa1-xAs quality on epitaxial growth conditions and InxGa1-xAs composition. All of the structures are fabricated by Molecular Beam Epitaxy (MBE). The effects of different growth conditions are being evaluated with a combination of characterization techniques, including Hall effect, photo-

luminescence, Transmission Electron Microscopy (TEM), and in-situ Reflection High Energy Electron Diffraction (RHEED). The electron spatial distribution and energy levels for quantized pseudomorphic structures are calculated self-consistently and compared with experiment. Critical layer thickness is shown to be a function of MBE growth temperature and the interruption of InxGa1-xAs growth with a few monolayers of GaAs is shown to smooth the InxGa1-xAs surface and provide strain energy relief, substantially extending the critical layer thickness. This new class of strained layer heterostructures which are here named thin strained superlattices (TSSL) extends the practical range of application of the GaAs-InxGa1-xAs system and is anticipated to be generally applicable to other strained layer systems. A publication describing the concept and demonstrating its practicality is tentatively scheduled for the May 22, 1989 issue of Applied Physics Letters. GRA

N89-26753# Army Lab. Command, Watertown, MA. Material Technology Lab.
PROPERTIES OF YTTRIA-TETRAGONAL ZIRCONIA POLYCRYSTAL (Y-TZP) MATERIALS AFTER LONG-TERM EXPOSURE TO ELEVATED TEMPERATURES Final Report
Jeffrey J. Swab Mar. 1989 28 p
(Contract DE-AI05-84OR-21411; DA Proj. 1L1-62105-AH-84)
(AD-A207064; MTL-TR-89-21) Avail: NTIS HC A03/MF A01 CSCL 20/13

Due to an unusual combination of high strength and toughness, tetragonal zirconia polycrystal (TZP) materials are candidates for use in advanced heat engines. The properties of these materials stem from the stress-assisted transformation of metastable tetragonal zirconia particles. However, after long times at elevated temperatures, this class of materials is susceptible to properties degradation due to the undesirable transformation of tetragonal zirconia to monoclinic zirconia upon cooling. Accordingly, a task was initiated to examine the extent and magnitude of this phenomenon's effect on the properties. Seven commercially available yttria-tetragonal polycrystal (Y-TZP) materials were evaluated. Room temperature properties were measured before and after heat treatments at 1000 C. Microstructure and phase stability were also examined. In all but one case, the Y-TZPs showed very little change in room temperature properties after long times at this temperature. strength. (jes) GRA

N89-26754# State Univ. of New York, Buffalo. Dept. of Chemistry.
MODEL OF LASER-INDUCED DEPOSITION ON SEMICONDUCTORS FROM LIQUID ELECTROLYTES
Z. C. Wu, Daniel A. Jelski, Thomas F. George, L. Nanai, and I. Hevesi Apr. 1989 28 p
(Contract N00014-86-K-0043)
(AD-A207097; UBUFFALO/DC/89/TR-98) Avail: NTIS HC A03/MF A01 CSCL 07/2

A model for laser induced electrolytic deposition on a semiconductor surface is developed. The laser induces two effects in the surface: thermal heating, which results in a thermal potential, and the Dember effect in which excited electrons and holes diffuse at different rates. The model is compared with experiment, and the ring-shaped deposit discovered is reproduced in the calculation. GRA

N89-26755# Ruhr Univ., Bochum (Germany, F.R.). Inst. fuer Mathematik.
ON THE ASYMPTOTIC BEHAVIOR OF THE INTERBAND LIGHT ABSORPTION COEFFICIENT ON THE FLUCTUATION SPECTRUM
W. Kirsch and L. A. Pastur (Academy of Sciences of the Ukrainian SSR, Kharkov.) Jan. 1989 24 p Submitted for publication
(SFB-237; Preprint-21; ETN-89-94601) Avail: NTIS HC A03/MF A01

It is proved that the interband light absorption coefficient has a nonrandom weak limit. A representation of the Laplace transform is obtained in the form of a Wiener integral. ESA

N89-26756# Rome Univ. (Italy). Dipartimento di Fisica.
AN ALGORITHM TO STUDY TUNNELING IN A WIDE CLASS OF ONE DIMENSIONAL MULTIWELL POTENTIALS, 2
Filippo Cesi Sep. 1988 31 p Submitted for publication
Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-622; ETN-89-94703) Avail: NTIS HC A03/MF A01

A simple algorithm to determine the behavior of the ground state wave function and to compute the lowest part of the spectrum of the Schroedinger operator in the semiclassical limit, when the potential has many absolute minima is described. The number of energy levels in the first band if the potential is a binary sequence of two types of barriers is determined, and a method to handle more general cases is given. The versatility of the algorithm is statistically estimated with the help of a computer program that implements it. About 99 percent of potentials in general classes are solvable with this method. ESA

N89-26757# Rome Univ. (Italy). Dipartimento di Fisica.
KONDO LATTICE HAMILTONIAN FOR HIGH Tc SUPERCONDUCTORS
C. Castellani, C. DiCastro, and M. Grilli 3 Oct. 1988 7 p Submitted for publication
(Preprint-629; ETN-89-94709) Avail: NTIS HC A02/MF A01

In the frame of a slave boson approach it is shown that the inclusion of a narrow metallic band inside the bonding-antibonding gap results in an effective Kondo lattice Hamiltonian which may be relevant for the description of high T sub c superconductors. Depending on the relative values of the effective parameters different scenarios are presented. ESA

77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

N89-26758*# Fermi National Accelerator Lab., Batavia, IL.
WINDOWS ON THE AXION
Michael S. Turner Apr. 1989 39 p Prepared in cooperation with Chicago Univ., IL
(Grant NAGw-1340)
(NASA-CR-185032; NAS 1.26:185032; FERMILAB-Conf-89/104-A) Avail: NTIS HC A03/MF A01 CSCL 20H

Peccei-Quinn symmetry with attendant axion is a most compelling, and perhaps the most minimal, extension of the standard model, as it provides a very elegant solution to the nagging strong CP-problem associated with the theta vacuum structure of QCD. However, particle physics gives little guidance as to the axion mass; a priori, the plausible values span the range: 10(-12)eV is approx. less than m(a) which is approx. less than 10(6)eV, some 18 orders-of-magnitude. Laboratory experiments have excluded masses greater than 10(4)eV, leaving unprobed some 16 orders-of-magnitude. Axions have a host of interesting astrophysical and cosmological effects, including, modifying the evolution of stars of all types (our sun, red giants, white dwarfs, and neutron stars), contributing significantly to the mass density of the Universe today, and producting detectable line radiation through the decays of relic axions. Consideration of these effects has probed 14 orders-of-magnitude in axion mass, and has left open only two windows for further exploration: 10(-6)eV is approx. less than m(a) is approx. less than 10(-3)eV and 1eV is approx. less than m(a) is approx. less than 5eV (hadronic axions only). Both these windows are accessible to experiment, and a variety of very interesting experiments, all of which involve heavenly axions, are being planned or are underway. Author

N89-26759# Idaho Univ., Moscow. Center for Applied Thermodynamic Studies.
STUDY OF DATA DISTRIBUTIONS AND FUNCTIONS FOR THE DEVELOPMENT OF THERMODYNAMIC EQUATIONS OF STATE Annual Report, Jun. 1987 - May 1988
Richard T. Jacobsen, Steven W. Beyerlein, Kent R. Bjornn, John Ostic, W. Paul Clarke, and Karen DenBraven Jul. 1988 42 p
(Contract GRI-5086-260-1421)
(PB89-173678; GRI-88/0175) Avail: NTIS HC A03/MF A01 CSCL 20M

Guidelines are being provided for efficiently measuring and correlating thermodynamic property data used in developing highly accurate equations of state for fluids used in the natural gas industry. Fitting experiments were conducted with pseudo-data calculated from a highly accurate equation of state for ethylene. Results of these experiments were analyzed using region by region summaries of random errors, three-dimensional plots, and contour maps showing local deviations in predicted properties. GRA

N89-26760# Rome Univ. (Italy). Dipartimento di Fisica.
STOCHASTIC VARIATIONAL PRINCIPLES AND QUANTUM MECHANICS
Francesco Guerra 7 Sep. 1988 12 p Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-619; ETN-89-94701) Avail: NTIS HC A03/MF A01

The links between the Eulerian and the Lagrangian approaches to stochastic variational principles are analyzed. It is shown how different time boundary conditions can select different classes of critical diffusions. General solutions, not necessarily irrotational are found by exploiting time boundary conditions where the local conditional expectations of the trajectory variations are put to zero. ESA

N89-26761# Istituto Nazionale di Fisica Nucleare, Rome (Italy).
LOOP SPACE REPRESENTATION OF QUANTUM GENERAL RELATIVITY
Carlo Rovelli and Lee Smolin (Yale Univ., New Haven, CT.) 13 Sep. 1988 84 p Submitted for publication Sponsored by NSF, Washington, DC and the Research Corp. Prepared in cooperation with Rome Univ., Italy; Syracuse Univ., NY and Trento Univ., Italy
(Preprint-620; ETN-89-94702) Avail: NTIS HC A05/MF A01

A representation for quantum general relativity is defined, in which exact solutions of the quantum constraints may be obtained. The representation is constructed by means of a noncanonical graded Poisson algebra of classical observables of general relativity, defined in terms of the Ashtekar's variables. The theory is quantized by constructing a linear representation of a deformation of this algebra. The failure of perturbation theory is shown to be not relevant to the problem of the existence of a nontrivial physical state space in quantum gravity. ESA

N89-26762# Aquila Univ. (Italy). Dipartimento di Fisica.
FERMIONIC FUNCTIONAL INTEGRAL AND THE TEMPORAL GAUGE OF QCD
G. C. Rossi and K. Yoshida (Rome Univ., Italy) 13 Dec. 1988 30 p Presented at Meeting on La Meccanica Quantistica di Feynman a 40 Anni dalla sua Proposta, Naples, Italy, Jun. 1988 Submitted for publication Prepared in cooperation with Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-644; ETN-89-94720) Avail: NTIS HC A03/MF A01

The formulation of quantum field theories in terms of the Feynman transition amplitude (Feynman kernel) is discussed. The construction of a path integral formula for fermionic amplitudes in the occupation number representation in the simplest case of a single fermion oscillator is described. Analogous formulas for conventional coherent state representations are given and generalized to include external (anticommuting) sources conjugated to the fermionic degrees of freedom. ESA

N89-26763# Rome Univ. (Italy). Dipartimento di Fisica.
HAUSDORFF DIMENSIONS IN TWO DIMENSIONAL MAPS AND THERMODYNAMIC FORMALISM
Giovanni Paladin and S. Vaienti 11 Jan. 1989 22 p Submitted for publication Prepared in cooperation with International Centre for Mechanical Sciences, Rome, Italy; Bologna Univ., Italy and Istituto Nazionale di Fisica Nucleare, Rome, Italy
(Preprint-649; ETN-89-94723) Avail: NTIS HC A03/MF A01

A set of dimensions which can be computed numerically is introduced. These are the Hausdorff dimensions of the Gibbs measure on the invariant sets of axiom A systems. The existence of a measure which has maximal dimension and can be relevant for the ergodic properties of the system is stressed. For hyperbolic maps of the plane with constant jacobian, the Bowen Ruelle formula is applied. Evidence that the relation remains valid for nonhyperbolic maps such as the Henon map is presented. ESA

N89-26764# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
THE EFFECTIVE CONDUCTIVITY OF A RANDOM SUSPENSION OF SPHERES TO SECOND ORDER
P. vanBeek 1988 17 p
(Rept-88-71; ISSN-0922-5641; ETN-89-94902) Copyright Avail: NTIS HC A03/MF A01

A solution method for the contribution of thermal interactions to the effective conductivity of a random suspension of spheres, presented in Beek (1988) is applied first to nonoverlap interactions and then simultaneously to nonoverlap and thermal interactions. The two-particle approximation agrees with that of Jeffrey (1973) and Felderhof, Ford and Cohen (1982). The simultaneous solution scheme can be extended to include nonoverlap and thermal contributions to higher orders. ESA

80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

N89-26765*# National Aeronautics and Space Administration, Washington, DC.
EDUCATIONAL AFFAIRS PLAN: A FIVE-YEAR STRATEGY Report, 1988-1992
Oct. 1987 17 p
(NASA-TM-101793; NAS 1.15:101793) Avail: NTIS HC A03/MF A01 CSCL 05C

A five-year plan is presented to guide the use of NASA resources in administering a focused and consistent set of aeronautics and space science education programs. Major initiatives outlined in this plan fall into two categories: programmatic priorities and institutional priorities. Programmatic priorities for this plan include elementary education, teacher education, underrepresented minority participation, educational technology and the Aerospace Education Services Project (AESP). Institutional priorities highlighted in this plan include university programs, educational publications and their distribution, educational partnerships with public and private organizations, educational research and evaluation, and activities of the educational affairs administration. The plan's aim is to directly and indirectly help to ensure an adequate pool of talented scientists, engineers and technical personnel to keep NASA at the forefront of advancements for the 21st century. K.C.D.

81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

N89-26766* National Aeronautics and Space Administration, Washington, DC.
MANAGEMENT: A BIBLIOGRAPHY FOR NASA MANAGERS
Apr. 1989 198 p

(NASA-SP-7500(23); NAS 1.21:7500(23)) Avail: NTIS HC A09 CSCL 05A

This bibliography lists 822 reports, articles and other documents introduced into the NASA Scientific and Technical Information System in 1988. Items are selected and grouped according to their usefulness to the manager as manager. Citations are grouped into ten subject categories: human factors and personnel issues; management theory and techniques; industrial management and manufacturing; robotics and expert systems; computers and information management; research and development; economics, costs and markets; logistics and operations management; reliability and quality control; and legality, legislation, and policy. Author

N89-26767*# Illinois Univ., Urbana-Champaign.
SCHEDULING PERIODIC JOBS USING IMPRECISE RESULTS
Jen-Yao Chung, Jane W. S. Liu, and Kwei-Jay Lin 30 Nov. 1987 33 p Submitted for publication
(Contract NAG1-613; N00014-87-K-0827)
(NASA-CR-183120; NAS 1.26:183120; UIUCDCS-R-87-1307; UILU-ENG-87-1780) Avail: NTIS HC A03/MF A01 CSCL 05A

One approach to avoid timing faults in hard, real-time systems is to make available intermediate, imprecise results produced by real-time processes. When a result of the desired quality cannot be produced in time, an imprecise result of acceptable quality produced before the deadline can be used. The problem of scheduling periodic jobs to meet deadlines on a system that provides the necessary programming language primitives and run-time support for processes to return imprecise results is discussed. Since the scheduler may choose to terminate a task before it is completed, causing it to produce an acceptable but imprecise result, the amount of processor time assigned to any task in a valid schedule can be less than the amount of time required to complete the task. A meaningful formulation of the scheduling problem must take into account the overall quality of the results. Depending on the different types of undesirable effects caused by errors, jobs are classified as type N or type C. For type N jobs, the effects of errors in results produced in different periods are not cumulative. A reasonable performance measure is the average error over all jobs. Three heuristic algorithms that lead to feasible schedules with small average errors are described. For type C jobs, the undesirable effects of errors produced in different periods are cumulative. Schedulability criteria of type C jobs are discussed. Author

N89-26768# Naval Weapons Center, China Lake, CA.
STATISTICAL AND BIOGRAPHICAL LABORATORY/CENTER DATA, REVISION 6
Nov. 1988 61 p
(AD-A206741; NWC-ADPUB-206-Rev-6) Avail: NTIS HC A04/MF A01 CSCL 05/1

This document contains biographical and statistical data for the following organizations: Space and Naval Warfare Systems command - David Taylor Research Center, Bethesda, Maryland; Naval Air Development Center, Warminster, Pennsylvania; Naval Coastal Systems Center, Panama City, Florida; Naval Ocean Systems Center, San Diego, California; Naval Surface Warfare Center, Dahlgren, Virginia; Naval Underwater Systems Center, Newport, Rhode Island; Naval Weapons Center, China Lake, California; The Johns Hopkins University Applied Physics Laboratory, Laurel, Md; Applied Research Laboratory, Pennsylvania State University, State College, Pennsylvania; Applied Research Laboratories, University of Texas, Austin, Texas; Applied Physics Laboratory, University of Washington, Seattle, Washington; (2) Office of the Chief of Naval Research; - Naval Research laboratory, Washington, D.C.; Naval Ocean Research and Development Activity, Stennis Space Center, Mississippi; Naval Environmental Prediction Research Facility, Monterey, California; Marine Physical Laboratory, San Diego, California. GRA

N89-26769# Air Force Office of Scientific Research, Bolling AFB, Washington, DC.
RESEARCH PROPOSAL QUARTERLY STATUS REPORT FOR JULY-SEPTEMBER 1988
Debra Tyrrell Oct. 1988 67 p
(AD-A206810; AFOSR-89-0390TR) Avail: NTIS HC A04/MF A01 CSCL 05/1

This Research Proposal Status Report is published quarterly as of March, June, September, and December of each year. It lists all the research proposals received by the Air Force Office of Scientific Research (AFOSR) in the six month period prior to the date of this report. Normally, decisions and actions are made within six months after receiving a research proposal. The action taken (i.e. initiated, declined, or withdrawn) will be listed in this report. The report is divided into two parts: Part I is the Institution Index which lists the proposals received, alphabetically by institution. Part II is the AFOSR Directorate Index in which the proposals received are listed alphabetically by Directorate and alphabetically by AFOSR Program Manager within the Directorate. The purpose of the quarterly report is to inform other Government sponsoring agencies of the proposals received by the AFOSR and the action taken on these proposals. GRA

N89-26770# Air Force Office of Scientific Research, Bolling AFB, Washington, DC.
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR) TECHNICAL REPORT SUMMARIES Quarterly Report No. 4, Oct. - Dec. 1988
Debra L. Tyrrell Jan. 1989 300 p
(AD-A206894; AFOSR-89-0470TR) Avail: NTIS HC A13/MF A01 CSCL 15/6

The AFOSR technical report summaries are published quarterly for each calendar year. They consist of a brief summary of each AFOSR technical report received in the Technical Information Devision and submitted to DTIC for that quarter. Author

N89-26771# Technische Univ., Delft (Netherlands). Faculty of Technical Mathematics and Informatics.
OPTIMIZATION WITH MULTIPLE OBJECTIVES
F. A. Lootsma 1988 36 p Presented at the 13th International Symposium on Mathematical Programming, Tokyo, Japan, 29 Aug. - 2 Sep. 1988
(Rept-88-75; ISSN-0922-5641; ETN-89-94906) Copyright Avail: NTIS HC A03/MF A01

A typical multiobjective optimization problem is considered: there is a continuum of alternatives (described by a finite number of variables under a finite number of constraints), a finite number of conflicting objectives, and a decision-making committee with diverging viewpoints. Basic concepts such as efficient solutions and dominance cones are introduced, and the geometric properties of the efficient set are outlined. Several classes of methods for solving the problem: multiobjective simplex methods, constraint methods with tradeoffs, and ideal-point methods are assessed. Because the potential of these methods depends critically on the information-processing capacity of human beings, the interface between the decision makers and the methods, that is, the nature and the number of items to be judged in the decision process, is emphasized. ESA

N89-26588*# McDonnell-Douglas Space Systems Co., Cocoa Beach, FL.
AN APPROACH TO KNOWLEDGE ENGINEERING TO SUPPORT KNOWLEDGE-BASED SIMULATION OF PAYLOAD GROUND PROCESSING AT THE KENNEDY SPACE CENTER
Shawn McManus and Michael McDaniel *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 113-125 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 05A

N89-26589*# Ford Aerospace and Communications Corp., Seabrook, MD. Space Systems Engineering Operation.
A HEURISTIC APPROACH TO INCREMENTAL AND REACTIVE SCHEDULING
Jide B. Odubiyi and David R. Zoch *In* NASA. Goddard Space Flight Center, The 1989 Goddard Conference on Space Applications of Artificial Intelligence Apr. 1989 p 127-140 (For primary document see N89-26578 20-63)
Avail: NTIS HC A17/MF A01 CSCL 05A

82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

N89-26772*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TECHNICAL COMMUNICATIONS IN AERONAUTICS: RESULTS OF AN EXPLORATORY STUDY, PART 1
Thomas E. Pinelli, Myron Glassman, Walter E. Oliu, and Rebecca O. Barclay (Rensselaer Polytechnic Inst., Troy, NY.) Feb. 1989 105 p
(Contract NAS1-18584)
(NASA-TM-101534-Pt-1; NAS 1.15:101534-Pt-1) Avail: NTIS HC A06/MF A01 CSCL 05B

A study was undertaken that explored several aspects of technical communications in aeronautics. The study, which utilized survey research in the form of a self-administered questionnaire, was sent to 2,000 randomly selected members of the American Institute of Aeronautics and Astronautics. Six hundred and six usable questionnaires (30.3 percent) were received by the established cut off date. The study had five objectives. The first was to solicit the opinions of aeronautical engineers and scientists regarding the importance of technical communications to their profession; second, to determine their use and production of technical communications; third, to seek their views on the content of an undergraduate course in technical communications; fourth, to determine their use of libraries/technical information centers; and finally, to determine the use and importance of computer and information technology to them. The findings add considerable information to the knowledge of technical communications practices among aeronautical engineers and scientists and reinforce some of the conventional wisdom about technical communications and question other widely-held notions. Author

N89-26773*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TECHNICAL COMMUNICATIONS IN AERONAUTICS: RESULTS OF AN EXPLORATORY STUDY, PART 2
Thomas E. Pinelli, Myron Glassman, Walter E. Oliu, and Rebecca O. Barclay (Rensselaer Polytechnic Inst., Troy, NY.) Feb. 1989 84 p
(Contract NAS1-18584)
(NASA-TM-101534-Pt-2; NAS 1.15:101534-Pt-2) Avail: NTIS HC A05/MF A01 CSCL 05B

A study was undertaken that explored several aspects of technical communications in aeronautics. The study, which utilized survey research in the form of a self-administered questionnaire, was sent to 2,000 randomly selected members of the American Institute of Aeronautics and Astronautics. Six hundred and six usable questionnaires (30.3 percent) were received by the established cut off date. Part 2 of this study lists appendices to part 1, including survey instrument, aggregate totals, cross tabulations, and open-ended comments. Author

N89-26774# National Library of Medicine, Bethesda, MD. MEDLARS Management Section.
THE BASICS OF SEARCHING MEDLINE
Mar. 1989 173 p
(PB89-146179) Avail: NTIS HC A08/MF A01 CSCL 05B

The Guide is designed to acquaint the health professional with the basic concepts and skills involved in using MEDLARS to retrieve information from its primary database, MEDLINE. It may be used in a formal training course or as a self-paced learning tool. After carefully reading the Guide and practicing searches on the MEDLINE database, the health professional and novice searcher will have enough knowledge to perform author searches as well as simple subject searches in MEDLINE. For more complicated searches, the health professional may wish to consult an experienced librarian or search analyst. GRA

N89-26775*# Research Inst. for Advanced Computer Science, Moffett Field, CA.
TELESCIENCE TESTBEDDING: AN IMPLEMENTATION APPROACH
Barry M. Leiner and James R. Weiss (National Aeronautics and Space Administration, Washington, DC.) Feb. 1988 13 p
(Contract NASw-4234)
(NASA-CR-185429; NAS 1.26:185429; RIACS-TR-88.2) Avail: NTIS HC A03/MF A01 CSCL 05B

Telescience is the term used to describe a concept being developed by NASA's Office of Space Science and Applications (OSSA) under the Science and Applications Information System (SAIS) Program. This concept focuses on the development of an ability for all OSSA users to be remotely interactive with all provided information system services for the Space Station era. This concept includes access to services provided by both flight and ground components of the system and emphasizes the accommodation of users from their home institutions. Key to the development of the telescience capability is an implementation approach called rapid-prototype testbedding. This testbedding is used to validate the concept and test the applicability of emerging technologies and operational methodologies. Testbedding will be used to first determine the feasibility of an idea and then the applicability to real science usage. Once a concept is deemed viable, it will be integrated into the operational system for real time support. It is believed that this approach will greatly decrease the expense of implementing the eventual system and will enhance the resultant capabilities of the delivered system. Author

N89-26776# Arizona Univ., Tucson. Computer Engineering Research Lab.
FUNCTIONAL DESCRIPTION AND FORMAL SPECIFICATION OF A GENERIC GATEWAY
Won Son Chang and Ralph Martinez Aug. 1988 227 p Sponsored by Army Inst. for Research in Management Information, Communications and Computer Science, Atlanta, GA
(Contract B-10-695-51)
(AD-A206581; ASQBG-C-89-020) Avail: NTIS HC A11/MF A01 CSCL 12/7

The generic gateway's characteristics can be summarized as follows: (1) It provides a communication protocol conversion up to transport layer; (2) The connection-less and connection-oriented subnetworks or their services can be interoperable; (3) The reliable data transport is expected by each individual subnetwork independently, because the reliable data transport control can not be expected as a global level by their control mismatch; (4) The generic gateway is decomposed with two distinguishable modules, subnetwork independent and subnetwork dependent blocks; (5) Each subnetwork more specifically subnetwork dependents blocks communicate with subnetwork independent block, through the universal service access points; (6) Each subnetwork interfacing modules can be designed and implemented independently. GRA

N89-26777# Arizona Univ., Tucson. Computer Engineering Research Lab.
PROTOCOL INTEROPERABILITY BETWEEN DDN AND ISO (DEFENSE DATA NETWORK AND INTERNATIONAL ORGANIZATION FOR STANDARDIZATION) PROTOCOLS Final Report

JianYi Tao and Ralph Martinez Aug. 1988 279 p Prepared for Georgia Inst. of Tech., Atlanta
(DA Proj. B-10-695-SI)
(AD-A206582; ASQBG-C-89-021) Avail: NTIS HC A13/MF A01 CSCL 25/5

This study focuses on the following four problem areas: (1) the general issues involved in protocol conversion, (2) protocol conversion in the DDN to ISO environment, (3) a detailed understanding of both protocol suites, and (4) approaches to achieve interoperability between DDN protocols (TCP/IP) and ISO protocols (TP-4). The study concludes with recommendations for future protocol research in the area of protocol interoperability.
GRA

N89-26778# Arizona Univ., Tucson. Computer Engineering Research Lab.
ISDN (INTEGRATED SERVICES DIGITAL NETWORK) INTERNET ENVIRONMENT AND STANDARDS ANALYSIS
Jim Su and Dan Christoffersen Aug. 1988 195 p Sponsored by Army Inst. for Research in Management Information, Communications and Computer Science,Atlanta, GA
(Contract B-10-695-SI)
(AD-A206583; ASQBG-C-89-022) Avail: NTIS HC A09/MF A01 CSCL 25/5

This paper prepared by the IGIS Research Team at the University of Arizona's Computer Engineering Research Lab is the Final Report on the subject of ISDN-Internet Environment and Standards Analysis. The intent of this report is to present background information on the current state of the art in ISDN technology, and to provide advice for implementing the new ISDN technology into existing Army communication systems. This information will be presented in Chapters two through six of this report, beginning with general information about ISDN and network standards, general approach to internetworking, and finally discussing the specific cases of ISDN-LAN and ISDN-DDN internetworking problems. The term ISDN, Integrated Services Digital Network, refers to a concept in communications technology rather than a particular type of hardware. ISDN can be thought of as a worldwide information system that uses international standards to deliver a broad range of services (voice, data, video, etc.) which are all integrated into a single end-to-end digital network. The concept of an ISDN has been around for a couple of decades, and now because of standardization and technological advancements in digital communications this concept is becoming a realization.
GRA

N89-26779# Naval Ocean Systems Center, San Diego, CA. Decision Support and Artificial Intelligence Systems Branch.
AN ASYNCHRONOUS INTERFACE BETWEEN A NATURAL LANGUAGE QUERY INTERPRETER AND A DATABASE MANAGEMENT SYSTEM Final Report, Feb. - Apr. 1988
L. E. Gadbois Feb. 1989 22 p
(AD-A206918; NOSC/TD-1482) Avail: NTIS HC A03/MF A01 CSCL 12/5

This report documents computer software which interfaces a Data Base Management System (DBMS) to a program which generates database requests. The software described controls the passing of Structured Query Language (SQL) commands into ORACLE and the capture of its output for return to the program which made the request. The software was designed for a DBMS running on a UNIX computer to be accessed by a program on the same or a remote computer. This remote can be running any hardware or operating system which has File Transfer Protocol (FTP) connection with the UNIX machine.
GRA

N89-26780# Naval Postgraduate School, Monterey, CA.
A MULTIMEDIA DATABASE MANAGEMENT SYSTEM SUPPORTING CONTENTS SEARCH IN MEDIA DATA Progress Report, Oct. 1988 - Jan. 1989
Vincent Y. Lum and Klaus Meyer-Wegener Mar. 1989 33 p
(AD-A207070; NPS52-89-020) Avail: NTIS HC A03/MF A01 CSCL 12/7

It is now feasible to store and manage in computers new types of data like text, images, graphics, and sound recordings. It is proposed that database management systems should be extended to organize these new types of data and to enable search based on their contents. Media objects are modeled as attributes of abstract data types. The contents are captured in terms of natural language descriptions and are translated by a parser into predicates for easy matching with query phrases. The implications of this approach are discussed: Data organization for multimedia including contents representation, the dictionary used by the parser to recognize words and assign predicates, rules to use semantic relationships in the query evaluation, and access paths to speed up the search for the descriptions. The result is an architecture for multimedia database management systems that combines the additional components needed with the conventional data management and identifies their ways of interaction. Three types of user interfaces are offered that require different levels of skill. The architecture is modular and allows the integration of more advanced AI techniques once they become available.
GRA

83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

No abstracts in this category.

84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

N89-26781*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPARISON OF CONCEPTUAL DESIGNS FOR 25 kWe ADVANCED STIRLING CONVERSION SYSTEMS FOR DISH ELECTRIC APPLICATION Final Report
Richard K. Shaltens and Jeffrey G. Schreiber 1989 16 p Prepared for presentation at the 24th Intersociety Energy Conversion Engineering Conference, Washington, DC, 6-11 Aug. 1989; sponsored in part by IEEE, AIAA, ANS, ASME, SAE, ACS, and AIChE
(Contract DE-AT04-85AL-33408)
(NASA-TM-102085; E-4806; DOE/NASA/33408-3; NAS 1.15:102085) Avail: NTIS HC A03/MF A01 CSCL 10B

The Advanced Stirling Conversion System (ASCS) Project is managed by NASA Lewis Research Center through a cooperative interagency agreement with DOE. Conceptual designs for the ASCS's were completed under parallel contracts in 1987 by Mechanical Technology Inc. (MTI) of Latham, NY, and Stirling Technology Company (STC) of Richland, WA. Each design features

a free-piston Stirling engine, a liquid metal heat pipe receiver, and a means to provide about 25 kW of electric power to a utility grid while meeting DOE's long term performance and cost goals. An independent assessment showed that both designs are manufacturable and have the potential to easily meet DOE's long term cost goals. Author

N89-26466*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
COMMERCIAL USERS PANEL
Joseph S. Byrd, Carl Flatau, David C. Hodge, Ralph Hollis, Eugene F. Leach, Ray Gilbert, John Cleland, Larry Leifer, Joseph Naser (Electric Power Research Inst., Palo Alto, CA.), and Samson D. Schmuter et al *In* Jet Propulsion Lab., California Inst. of Tech., Proceedings of the Workshop on Space Telerobotics, Volume 1 1 Jul. 1987 p 113-123 Prepared in cooperation with Bureau of Mines, Pittsburgh, PA; Perry Offshore, Riviera Beach, FL; andFord Motor Co., Detroit, MI (For primary document see N89-26454 20-63)
Avail: NTIS HC A16/MF A01 CSCL 05A

88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

N89-26782 Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
WARM GAS AND SPATIAL VARIATIONS OF MOLECULAR EXCITATION IN THE NUCLEAR REGION OF IC 342
A. Eckart, D. Downes, R. Genzel, A. I. Harris, D. T. Jaffe (Texas Univ., Austin.), and W. Wild Feb. 1989 32 p Submitted for publication
(MPE-Preprint-141; ETN-89-94586) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514
Eggenstein-Leopoldshafen 2, Federal Republic of Germany

Maps of selected transitions in the nuclear region of the galaxy IC 342 are presented. The observations were taken with the IRAM 30 m telescope. It is shown that molecular gas in the nucleus is warm and that physical conditions vary with position in the galaxy. Far infrared measurement of the OI 63 micron fine structure line indicate that the atomic and molecular gas pressures are both equal to 300,000/cc/K, 10 times larger than in our Galaxy. ESA

N89-26783*# Fermi National Accelerator Lab., Batavia, IL.
NEUTRON STARS AND WHITE DWARFS IN GALACTIC HALOS
Dongsu Ryu, Keith A. Olive, and Joseph Silk (California Univ., Berkeley.) May 1989 29 p Sponsored in part by a Presidential Young Investigator Award and the NSF
(Contract NAGw-1340; DE-AC02-83ER-40105)
(NASA-CR-185352; NAS 1.26:185352; FERMILAB-Pub-89/119-A)
Avail: NTIS HC A03/MF A01 CSCL 03A

The possibility that galactic halos are composed of stellar remnants such as neutron stars and white dwarfs is discussed. On the basis of a simple model for the evolution of galactic halos, researchers follow the history of halo matter, luminosity, and metal and helium abundances. They assume conventional yields for helium and the heavier elements. By comparing with the observational constraints, which may be considered as fairly conservative, it is found that, for an exponentially decreasing star formation rate (SFR) with e-folding time tau, only values between 6 x 10(8) less than similar to tau less than similar to 2 x 10(9) years are allowed together with a very limited range of masses for the initial mass function (IMF). Star formation is allowed for 2 solar mass less than similar to m less than similar to 8 solar mass if tau = 2 x 10(9) years, and for 4 solar mass less than similar to m less than similar to 6 solar mass if tau = 10(9) years. For tau = 6 x 10(8) years, the lower and upper mass limits merge to similar to 5 solar mass. Researchers conclude that, even though the possibility of neutron stars as halo matter may be ruled out, that of white dwarfs may still be a viable hypothesis, though with very stringent constraints on allowed parameters, that merits further consideration. Author

N89-26784*# Pennsylvania State Univ., State College.
THE SEARCH FOR ABSORPTION OF 1 keV X-RAYS BY THE SMALL MAGELLANIC CLOUD
Brad Marazas 30 May 1989 37 p
(Grant NAG8-601)
(NASA-CR-185348; NAS 1.26:185348) Avail: NTIS HC A03/MF A01 CSCL 03A

The contribution of the extragalactic component of the diffuse background to the 1 keV energy band remains unknown. An effective way to ascertain this contribution is to measure the absorption of the extragalactic component by the neutral hydrogen in the Small Magellanic Cloud (SMC) with an instrument capable of eliminating point sources from the X-ray data that compensate for absorption. The image proportional counter data from the Einstein observatory can be used for this purpose. Additionally, any extended emission must also be eliminated. The resulting source free data can be compared to the neutral hydrogen and the amount of absorption can then be obtained when compared to the diffuse flux away from the SMC. However, due to other types of radiation contaminating the X-ray data, a true measure of the X-ray absorption was not obtained. Author

N89-26785 California Univ., Santa Cruz.
DOPPLER IMAGING OF THE MAGNETIC Ap STARS Ph.D. Thesis
Artie Peter Hatzes 1988 246 p
Avail: Univ. Microfilms Order No. DA8905622

An application of the Doppler imaging technique is presented for mapping the surface distribution of elements on rapidly rotating magnetic Ap stars. The principles of maximum entropy image reconstruction are used to solve a matrix equation relating the local equivalent width distribution on the surface of a star to a sequence of time resolved spectral lines profiles. The method's ability at recovering both the shape and location of abundance features strictly from spectral line profile variations is demonstrated by reconstructing several test input distributions. The method can also accurately recover both depleted and enhanced abundance features. Rigorous tests show that the method is insensitive to wrong assumptions about the inclination of the star. Using high signal-to-noise and high resolution spectral line profiles obtained at Lick Observatory, this technique was used to derive the distribution of silicon on 7 stars and chromium on 6 stars. The Doppler images show that silicon and possibly chromium is depleted in spots coincident with the magnetic poles of these stars, and enhanced near regions where one expects the field lines to be horizontal. These results are consistent with the predictions of diffusion theory and provide strong direct evidence that selective diffusion is the mechanism responsible for the spectral variations. Several of the Doppler images show evidence for depleted bands as well as spots. These may be due to the effects of horizontal diffusion or the presence of a strong quadrupole magnetic field. These images are used to derive the magnetic field configuration in these stars. The stars show a biomodal distribution in obliquity angles centered on 75 and 50 degree, and decentering parameters near 0.2 stellar radii. The non-axisymmetric fields evident in the abundance distributions are consistent with the hypothesis that a redistribution of surface fields occurs in rapidly rotating magnetic Ap stars. Dissert. Abstr.

N89-26786*# Perkin-Elmer Corp., Danbury, CT. Electro-Optical Technology Div.
IMAGING PHASED TELESCOPE ARRAY STUDY Final Report
James E. Harvey 15 Jan. 1989 72 p
(Contract NAS8-36105)
(NASA-CR-183661; NAS 1.26:183661; PR-B11-0064) Avail: NTIS HC A04/MF A01 CSCL 03A

The problems encountered in obtaining a wide field-of-view with large, space-based direct imaging phased telescope arrays were considered. After defining some of the critical systems issues, previous relevant work in the literature was reviewed and summarized. An extensive list was made of potential error sources and the error sources were categorized in the form of an error budget tree including optical design errors, optical fabrication errors, assembly and alignment errors, and environmental errors. After choosing a top level image quality requirment as a goal, a preliminary tops-down error budget allocation was performed; then, based upon engineering experience, detailed analysis, or data from the literature, a bottoms-up error budget reallocation was performed in an attempt to achieve an equitable distribution of difficulty in satisfying the various allocations. This exercise provided a realistic allocation for residual off-axis optical design errors in the presence of state-of-the-art optical fabrication and alignment errors. Three different computational techniques were developed for computing the image degradation of phased telescope arrays due to aberrations of the individual telescopes. Parametric studies and sensitivity analyses were then performed for a variety of subaperture configurations and telescope design parameters in an attempt to determine how the off-axis performance of a phased telescope array varies as the telescopes are scaled up in size. The Air Force Weapons Laboratory (AFWL) multipurpose telescope testbed (MMTT) configuration was analyzed in detail with regard tc image degradation due to field curvature and distortion of the individual telescopes as they are scaled up in size. B.G.

N89-26787*# Smithsonian Astrophysical Observatory, Cambridge, MA.
A NORMAL INCIDENCE X-RAY TELESCOPE (NIXT) SOUNDING ROCKET PAYLOAD Final Report, 1 Nov. 1982 - 31 Jan. 1989
Leon Golub May 1989 15 p
(Grant NAGw-397)
(NASA-CR-185438; NAS 1.26:185438) Avail: NTIS HC A03/MF A01 CSCL 03A

Work on the High Resolution X-ray (HRX) Detector Program is described. In the laboratory and flight programs, multiple copies of a general purpose set of electronics which control the camera, signal processing and data acquisition, were constructed. A typical system consists of a phosphor convertor, image intensifier, a fiber optics coupler, a charge coupled device (CCD) readout, and a set of camera, signal processing and memory electronics. An initial rocket detector prototype camera was tested in flight and performed perfectly. An advanced prototype detector system was incorporated on another rocket flight, in which a high resolution heterojunction vidicon tube was used as the readout device for the H(alpha) telescope. The camera electronics for this tube were built in-house and included in the flight electronics. Performance of this detector system was 100 percent satisfactory. The laboratory X-ray system for operation on the ground is also described. K.C.D.

N89-26788*# Smithsonian Astrophysical Observatory, Cambridge, MA.
ASTROMETRIC OBSERVATIONS OF COMETS AND ASTEROIDS AND SUBSEQUENT ORBITAL INVESTIGATIONS Final Report, 1 Nov. 1973 - 31 Mar. 1989
Richard E. McCrosky and Brian G. Marsden May 1989 65 p
(Grant NGR-09-015-212)
(NASA-CR-185446; NAS 1.26:185446) Avail: NTIS HC A04/MF A01 CSCL 03A

Observations were made with the 155-cm reflector at the Oak Ridge Observatory. Since the last semiannual report (issued in November 1988) there have been 20 observations of comets, 146 of numbered minor planets and 135 of minor planets that were unnumbered at the time of observation. The orbit computations made during this period mainly applied to new discoveries, which have recently been exceptionally numerous. 1989 has already produced five new Apollo objects, and the new-moon period in early January produced a record six new comets. Author

N89-26789# Geneva Observatory (Switzerland).
ON THE EVOLUTIONARY STATUS AND INSTABILITY MECHANISM OF THE LUMINOUS BLUE VARIABLES (LBV)
Andre Maeder 1989 6 p Presented at the 113th IAV Colloquium, Physics of LBV, Val Morin, Quebec, Aug. 1988 Submitted for publication
(Ser-C-Prepubl-Fasc-33; ETN-89-94927) Avail: NTIS HC A02/MF A01

Stella evolutionary sequences leading to Luminous Blue Variables (LBV) are examined. The sequence O-Of-LBV-WR-SN is well supported by the models; some LBV with relatively lower luminosity may turn into OH/IR sources. The overall duration of the LBV phase depends mainly on the average mass loss rate; for 0.001 solar mass/yr it lasts 10,000 yr. Very massive stars undergo, when they reach log T sub eff = 3.9, strong departure from hydrostatic equilibrium due to supra-Eddington luminosoties at some depth in the outer layers. This results in heavy mass loss, as the growth rate of the instability is very fast. The amount of mass ejected in a shell episode is mainly determined by the mass of a layer such that its thermal adjustment timescale is within an order of magnitude of the stellar dynamical timescale. Simulations of B-light curves due to shell ejections by LBV are performed and sensitive properties are identified. ESA

N89-26790# Geneva Observatory (Switzerland).
W SGR: PULSATION AND ORBIT
J. Babel, G. Burki, M. Mayor, C. Waelkens, and Y. Chmielewski 1989 17 p Submitted for publication
(Ser-C-Prebubl-Fasc-34; ETN-89-94928) Avail: NTIS HC A03/MF A01

The observations of the cepheid star W Sgr in radial velocity with CORAVEL and in the Geneva photometry are analyzed. A radius of 56 plus or minus 2 solar radii is derived by using CORAVEL Vr, V magnitude and Geneva (B - V) index. The analysis of the characteristics of the CORAVEL dip parameters shows that: the dip broadening due to axial rotation and turbulence (and other effects) is well correlated to the variation of the acceleration of the stellar surface during the pulsation cycle; and the dip area depends primarily on the effective temperature, but also on another parameter which could be the microturbulence. The analysis of all the photometric and radial velocity data made since the end of the last century shows that the period of W Sgr increased during this period in a way which is not possible to specify: a regular variation and a two periods behavior are possible. The variability of the bump observed on the radial velocity curves is discussed on the basis of the same data. The variation of the mean value of the pulsational radial velocity curve can be described by an orbital motion with parameters: P = 1780 plus or minus 5 days, K = 2.35 plus or minus 0.47 km/sec, e = 0.52 plus or minus 0.14, and Gamma = -28.27 plus or minus 0.21 km/sec. These values are based on all the radial velocity data available since Curtiss (1904), but with weights giving most importance to the CORAVEL data. If the companion detected by speckle interferometry (Morgan et al 1977) and the known faint visual companion are real and physically related to W Sgr, this Cepheid could belong to a stellar system with up to 4 components. ESA

90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics*.

N89-26791*# Fermi National Accelerator Lab., Batavia, IL.
LIGHT PROPAGATION AND THE DISTANCE-REDSHIFT RELATION IN A REALISTIC INHOMOGENEOUS UNIVERSE
Toshifumi Futamase (Hirosaki Univ., Japan) and Misao Sasaki Apr. 1989 26 p Prepared in cooperation with Hiroshima Univ., Takehara (Japan)
(Grant NAGw-1340)
(NASA-CR-185041; NAS 1.26:185041; FERMILAB-Pub-89/111-A)
Avail: NTIS HC A03/MF A01 CSCL 03B

The propagation of light rays in a clumpy universe constructed by cosmological version of the post-Newtonian approximation was investigated. It is shown that linear approximation to the propagation equations is valid in the region where zeta is approximately less than 1 even if the density contrast is much larger than unity. Based on a gerneral order-of-magnitude statistical consideration, it is argued that the linear approximation is still valid where zeta is approximately greater than 1. A general formula for the distance-redshift relation in a clumpy universe is given. An explicit expression is derived for a simplified situation in which the effect of the gravitational potential of inhomogeneities dominates. In the light of the derived relation, the validity of the Dyer-Roeder distance is discussed. Also, statistical properties of light rays are investigated for a simple model of an inhomogeneous universe. The result of this example supports the validity of the linear approximation.
Author

N89-26792*# Fermi National Accelerator Lab., Batavia, IL.
RATE FOR ANNIHILATION OF GALACTIC DARK MATTER INTO TWO PHOTONS
Gian F. Giudice and Kim Griest Apr. 1989 35 p Prepared in cooperation with Chicago Univ., IL
(Grant NAGw-1340)
(NASA-CR-185029; NAS 1.26:185029; FERMILAB-Pub-89/113-A)
Avail: NTIS HC A03/MF A01 CSCL 03B

A calculation of the cross section for neutralino-neutralino annihilation into two photons is performed and applied to dark matter in the galactic halo to find the counting rate in a large gamma ray detector such as EGRET (Energetic Gamma Ray Experiment Telescope) or ASTROGAM. Combining constraints from particle accelerators with the requirement that the neutralinos make up the dark matter, it is found that rates of over a few dozen events per year are unlikely. The assumptions that go into these conclusions are listed. Other particle dark matter candidates which could give larger and perhaps observable signals are suggested.
Author

N89-26793*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
IDEAL BLACK HOLE GAS
Larry L. Smalley (Alabama Univ., Huntsville.) 7 Aug. 1989 12 p Submitted for publication
(NASA-TM-101788; NAS 1.15:101788) Avail: NTIS HC A03/MF A01 CSCL 03B

The concept of a primordial blackhole fluid with intrinsic spin density is examined along with its consequence for supercluster-sized, i.e., large scale voids, and the missing mass question.
K.C.D.

N89-26794*# Fermi National Accelerator Lab., Batavia, IL.
GRAVITATIONAL RADIATION FROM EXTREME KERR BLACK HOLE
Misao Sasaki and Takashi Nakamura (National Lab. for High Energy Physics, Ibaraki, Japan) 17 May 1989 20 p Sponsored in part by the DOE
(Grant NAGw-1340)
(NASA-CR-185350; NAS 1.26:185350; FERMILAB-Pub-89/122-A)
Avail: NTIS HC A03/MF A01 CSCL 03B

Gravitational radiation induced by a test particle falling into an extreme Kerr black hole was investigated analytically. Assuming the radiation is dominated by the infinite sequence of quasi-normal modes which has the limiting frequency m/(2M), where m is an azimuthal eigenvalue and M is the mass of the black hole, it was found that the radiated energy diverges logarithmically in time. Then the back reaction to the black hole was evaluated by appealing to the energy and angular momentum conservation laws. It was found that the radiation has a tendency to increase the ratio of the angular momentum to mass of the black hole, which is completely different from non-extreme case, while the contribution of the test particle is to decrease it.
Author

N89-26795*# California Univ., Berkeley. Space Sciences Lab.
COMPLETE POSITIVE ION, ELECTRON, AND RAM NEGATIVE ION MEASUREMENTS NEAR COMET HALLEY (COPERNIC) PLASMA EXPERIMENT FOR THE EUROPEAN GIOTTO MISSION Final Report, 15 Apr. 1982 - 31 Mar. 1988
Robert P. Lin 11 May 1988 23 p
(Contract NASw-3575)
(NASA-CR-185345; NAS 1.26:185345) Avail: NTIS HC A03/MF A01 CSCL 03B

Participation of U.S. scientists on the COPERNIC (COmplete Positive ions, Electrons and Ram Negative Ion measurements near Comet Halley) plasma experiment on the Giotto mission is described. The experiment consisted of two detectors: the EESA (electron electrostatic analyzer) which provided three-dimensional measurements of the distribution of electrons from 10 eV to 30 keV, and the PICCA (positive ion cluster composition analyzer) which provided mass analysis of positively charged cold cometary ions from mass 10 to 210 amu. In addition, a small 3 deg wide sector of the EESA looking in the ram direction was devoted to the detection of negatively charged cold cometary ions. Both detectors operated perfectly up to near closest approach (approx. 600 km) to Halley, but impacts of dust particles and neutral gas on the spacecraft contaminated parts of the data during the last few minutes. Although no flight hardware was fabricated in the U.S., The U.S. made very significant contributions to the hardware design, ground support equipment (GSE) design and fabrication, and flight and data reduction software required for the experiment, and also participated fully in the data reduction and analysis, and theoretical modeling and interpretation. Cometary data analysis is presented.
K.C.D.

N89-26796 Washington Univ., Seattle.
DUST FORMATION AROUND NOVAE Ph.D. Thesis
Donald James Johnson 1988 172 p
Avail: Univ. Microfilms Order No. DA8826918

The origin of the dust grains, thought to be a few tenths of a micron or larger in size, which can be found around some novae is examined. Both nucleation and grain growth are treated. The problem is first examined in a limited way by studying grain growth and bypassing nucleation. It is shown that grains a few tenths of a micron in radius can form in geometrically thick, low density gas shells, but micron size particles would require much thinner shells. If the micron size dust exists, it suggests that a nova blows off a relatively thin shell of carbon-rich material which somehow stays thin (thickness much less than radius) even as it expands, or alternatively, that a nova blows off clumps of dense carbon-rich gas (n(c) = 10 to the 8th power 1/(cm cu)). The presence of large micron size dust particles would therefore reveal something interesting about the nova eruption. Nucleation is then examined. It enumerates the processes which tend to prevent nucleation around a nova. The first obstacle is photoionization; if the nova's radiating temperature is too high the carbon is entirely ionized and nucleation is impossible. In the early stages of the eruption when the nova is relatively cool, 6-11 eV photons will disrupt small molecules, preventing nucleation. Nucleation might still be possible if the presence of hydrogen in the small molecules protects the carbon skeleton from disruption. Since nucleation appears improbable around an erupting nova, it is suggested that dust forms when the ejected material reaches the condensation radius and accretes on pre-existing nucleation sites. Such sites may orbit around the star before the eruption, too small to obstruct

much light unless they grow. When the eruption begins, sites inside the condensation radius evaporate, while those outside may survive the initial encounter with ejecta and begin to grow.
Dissert. Abstr.

N89-26797 California Univ., Santa Cruz.
THE CIRCUMNUCLEAR ENVIRONMENT OF NEARBY NON-INTERACTING SEYFERT GALAXIES Ph.D. Thesis
Richard William Pogge 1988 234 p
Avail: Univ. Microfilms Order No. DA8905630

An investigation into the physical conditions prevailing in the regions immediately surrounding the active nuclei in 20 nearby, non-interacting Seyfert galaxies is reported. CCD interference-band images isolating the bright emission lines of H alpha + (N II) Lambda Lambda 6548, 6583 and (O III) Lambda 5007 were obtained to search for spatially extended circumnuclear emission regions. Long-slit, low resolution spectrophotometry of interesting cases was used to probe the ionization state of the extended emission regions. For comparison, a CCD H alpha + (N II) interference-band imaging survey of a statistically significant sample of 91 bright non-Seyfert spiral galaxies meeting the same non-interaction criteria was carried out. Only three out of nine Seyfert 1s have spatially extended ionized gas regions compared with eight out of eleven Seyfert 2s. Enhanced circumnuclear star formation is uncommon to both Seyfert 1s and 2s. Extended emission in Seyfert 1s has essentially the same morphology in both H alpha + (N II) and (O III) emission. In the Seyfert 2s, the H alpha + (N II) and (O III) images show different extended emission morphologies. The (O III) emission regions appear as either one- or two-sided structures, four of which are resolved into two distinct cones of high-ionization gas emanating from the active nucleus. Spectrophotometry of these extended regions shows the gas to be in a high excitation state, consistent with photoionization by a hard-photon spectrum, possibly the nuclear power-law continuum. For Seyfert 1s and 2s with published radio maps, the radio continuum and optical emission-line structures are roughly aligned, but not correlated knot-for-knot. The morphology and ionization of these regions suggests collimation of the nuclear ionizing radiation field. Dissert. Abstr.

N89-26363*# Houston Univ., TX. Dept. of Biochemical and Biophysical Sciences.
CHEMICAL EVOLUTION: A SOLAR SYSTEM PERSPECTIVE
J. Oro *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 46-49 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights. For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

N89-26798*# Lunar and Planetary Inst., Houston, TX.
ANTARTIC METEORITE LOCATION MAP SERIES
John Schutt, ed., Brian Fessler, ed., and William Cassidy, ed. 1989 60 p
(Contract NASw-4066; NSF DPP-77-21742; NSF DPP-78-21104; NSF DPP-83-14496)
(NASA-CR-181510; NAS 1.26:181510; LPI-TR-89-02) Avail: NTIS HC A04/MF A01 CSCL 03B

Antarctica has been a prolific source of meteorites since meteorite concentrations were discovered in 1969. The Antarctic Search For Meteorites (ANSMET) project has been active over much of the Trans-Antarctic Mountain Range. The first ANSMET expedition (a joint U.S.-Japanese effort) discovered what turned out to be a significant concentration of meteorites at the Allan Hills in Victoria Land. Later reconnaissance in this region resulted in the discovery of meteorite concentrations on icefields to the west of the Allan Hills, at Reckling Moraine, and Elephant Moraine. Antarctic meteorite location maps (reduced versions) of the Allan Hills main, near western, middle western, and far western icefields and the Elephant Moraine icefield are presented. Other Antarctic meteorite location maps for the specimens found by the ANSMET project are being prepared. K.C.D.

N89-26799*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SOLAR POWER FOR THE LUNAR NIGHT
Geoffrey A. Landis May 1989 19 p Presented at the 9th Biennial SSI/Princeton Conference on Space Manufacturing, Princeton, NJ, 10-13 May 1989; sponsored by Space Studies Inst. (NASA-TM-102127; E-4913; NAS 1.15:102127) Avail: NTIS HC A03/MF A01 CSCL 03B

Providing power over the 354 hour lunar night provides a considerable challenge to solar power concepts for a moonbase. Concepts are reviewed for providing night power for a solar powered moonbase. The categories of solutions considered are electrical storage, physical storage, transmitted power, and innovative concepts. Electrical storage is the most well-developed option. Less developed electrical storage options are capacitors and superconducting inductors. Physical storage options include storage of potential energy and storage of energy in flywheels. Thermal storage has potentially high energy/weight, but problems of conduction and radiation losses during the night need to be addressed. Transmitted power considers use of microwave or laser beams to transmit power either from orbit or directly from the Earth. Finally, innovative concepts proposed include reflecting light from orbital mirrors, locating the moonbase at a lunar pole, converting reflected Earthlight, or moving the moonbase to follow the sun. Author

N89-26340*# Geological Survey, Menlo Park, CA.
RATIONALE FOR MARS ROVER/SAMPLER RETURN MISSION Abstract Only
Michael H. Carr *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 11 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26341*# San Jose State Univ., CA. Dept. of Chemistry.
USE OF NEAR INFRARED CORRELATION SPECTROSCOPY FOR QUANTITATION OF SURFACE IRON, ABSORBED WATER AND STORED ELECTRONIC ENERGY IN A SUITE OF MARS SOIL ANALOG MATERIALS Abstract Only
Lelia M. Coyne, Amos Banin (Hebrew Univ., Jerusalem, Israel), Glenn Carle, James Orenberg, and Thomas Scattergood *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 12 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26350*# Cornell Univ., Ithaca, NY.
ANCIENT LAKES ON MARS? Abstract Only
J. M. Goldspiel and S. W. Squyres *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 26 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26352*# Wisconsin Univ., Madison.
A CORE HANDLING DEVICE FOR THE MARS SAMPLE RETURN MISSION Abstract Only
Owen Gwynne *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 29 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26359*# Louisiana State Univ., Baton Rouge. Dept. of Geology.
THE GEOLOGICAL RECORD OF LIFE 3500 Ma AGO: COPING WITH THE RIGORS OF A YOUNG EARTH DURING LATE ACCRETION Abstract Only
Donald R. Lowe *In* NASA, Ames Research Center, Exobiology

and Future Mars Missions Mar. 1989 p 40-41 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26361*# Academy of Sciences (USSR), Moscow. Space Research Inst.
MARS 94 MISSION: CURRENT PLANS AND SCIENCE Abstract Only
Lev Mukhin and Mikhail Ya. Marov *In* NASA, Ames Research Center, Exobiology and Future Mars Missions Mar. 1989 p 43 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

N89-26362*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ARE THERE CARBONATE DEPOSITS IN THE VALLES MARINERIS, MARS? Abstract Only
Susan S. Nedell and Christopher P. McKay *In its* Exobiology and Future Mars Missions Mar. 1989 p 44-4 Previously announced in IAA as A88-24972 (For primary document see N89-26334 20-51)
Avail: NTIS HC A04/MF A01 CSCL 03B

92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

N89-26800*# National Center for Atmospheric Research, Boulder, CO. High Altitude Observatory.
THE 3RD JOINT SOLAR DYNAMICS PROJECT DATA SUMMARY: SOLAR MAGNETIC FIELD, CHROMOSPHERIC AND CORONAL OBSERVATIONS NEAR THE TIME OF THE 18 MARCH 1988 SOLAR ECLIPSE
D. G. Sime, C. J. Garcia, W. E. Lundin, E. A. Yasukawa, D. L. Mickey, and B. Labonte (Hawaii Univ., Honolulu.) Nov. 1988 90 p
(Grants NGL-12-001-11; NSF ATM-87-09659)
(NASA-CR-185714; NAS 1.26:185714; PB89-163695; NCAR/TN-326-STR) Avail: NTIS HC A05/MF A01 CSCL 03B

The general goal of the HAO/University of Hawaii Joint Solar Dynamics Project is to establish the relationships that exist between the solar magnetic field which is detected in the photosphere and the structure and evolution of the corona. The SOLDYN programs of 1982 and 1983 demonstrated the ability to use existing instruments to gather data of value in the pursuit of that goal. The goals for the observations in 1988 are as follows: (1) Document the state of the sun, from the photosphere up through the chromosphere and out into the corona for the approximately four-week interval around the total solar eclipse of 18 March 1988, and (2) Identify the relationship between the photospheric magnetic fields and the temperature and density structure of the corona. The reduced observations made during this SOLDYN 3 period necessary to achieve these goals are provided. The observations are presented both in the form of daily photographic and photo-electric measurements, and in synoptic format for the period. GRA

93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

N89-26801# Max-Planck-Inst. fuer Kernphysik, Heidelberg (Germany, F.R.).
MEASURING THE CHEMICAL COMPOSITION OF COSMIC RAYS AT 10 TO THE 13TH TO 15TH POWER eV BY UTILIZING THE SOLAR AND GEOMAGNETIC FIELDS
J. Heintze, P. Lennert, S. Polenz, B. Schmidt, J. Spitzer (Heidelberg Univ., Germany, F.R.), W. Brueckner, W. Hofmann, and B. Povh 1989 15 p
(MPI-H-1989-V-7; ETN-89-94605) Avail: NTIS HC A03/MF A01

The proposal of Lloyd-Evans (1985) that the average charge of particles in cosmic radiation near 10 to the 14th eV can be determined by observing the effect of the solar magnetic field on the Sun's shadow in the angular distribution of energetic primary cosmic ray particles, is shown to be realizable with an air shower array proposed for gamma ray astronomy. The same measurement provides information on the integrated strength of the solar magnetic field. As the array is sensitive and provides good angular resolution down to a few times 10 to the 12th eV, more detailed results on the primary composition near 10 to the 13th eV can be obtained by investigating the shape of the shadow of the Moon as affected by the geomagnetic field. ESA

N89-26802# Rome Univ. (Italy). Dipartimento di Fisica.
COSMIC RAYS AND COSMOLOGICAL SPECULATIONS IN THE 1920s
M. DeMaria and A. Russo (Palermo Univ., Italy) 7 Jul. 1988 15 p Presented at the International Symposium on Modern Cosmology in Retrospect, Bologna, Italy, 20-23 May 1988 Submitted for publication
(Preprint-610; ETN-89-94698) Avail: NTIS HC A03/MF A01

A controversy which opposed the American physicist Millikan to the English scientist Jeans is discussed. It is an interesting aspect of a debate about the cultural and social value of science which shook the scientific comunity as well as the public. Ideological and religious belief concurred with Millikan's scientific work in designing this unified perspective. This American optimism and progressive ideology of science clashed with Jeans' and Eddington's claim of the cosmological validity of the second law of thermodynamics. ESA

99 GENERAL

N89-26803*# National Aeronautics and Space Administration, Washington, DC.
ASTRONAUTICS AND AERONAUTICS, 1985: A CHRONOLOGY
Bette R. Janson Mar. 1988 545 p
(NASA-SP-4025; NAS 1.21:4025; LC-65-60308) Avail: NTIS HC A23/MF A01; also available SOD HC $22.00 as 033-000-01022-2 CSCL 05B

This book is part of a series of annual chronologies of significant events in the fields of astronautics and aeronautics. Events covered are international as well as national, in political as well as scientific and technical areas. This series is an important reference work used by historians, NASA personnel, government agencies, and congressional staffs, as well as the media. Author

N89-26804*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
SCIENCE IN ORBIT: THE SHUTTLE AND SPACELAB EXPERIENCE, 1981-1986
1988 131 p Original contains color illustrations

(NASA-NP-119; NAS 1.83:119) Avail: NTIS HC A07/MF A01 CSCL 05D

Significant achievements across all scientific disciplines and missions for the first six years of Shuttle flights are presented. Topics covered include science on the Space Shuttle and Spacelab, living and working in space, studying materials and processes in microgravity, observing the sun and earth, space plasma physics, atmospheric science, astronony and astrophysics, and testing new technology in space. Future research aboard the Shuttle/Spacelab is also briefly mentioned. K.C.D.

N89-26805*# National Aeronautics and Space Administration, Washington, DC.

ORDERS OF MAGNITUDE: A HISTORY OF THE NACA AND NASA, 1915-1990

Roger E. Bilstein Jul. 1989 171 p ERRATUM: Coauthored by Frank W. Anderson, Jr.

(NASA-SP-4406; NAS 1.21:4406) Avail: NTIS HC A08/MF A01 CSCL 05D

This edition brings up to date the history of U.S. agencies for space exploration, the NACA and NASA, from 1915 through 1990. Early aviation and aeronautics research are described, with particular emphasis on the impact of the two world wars on aeronautics development and the postwar exploitation of those technologies. The reorganization and expansion of the NACA into NASA is described in detail as well as NASA's relationship with industry, the university system, and international space agencies such as the ESA. The dramatic space race of the 1950 and 1960s is recounted through a detailed histroy of the Gemini and Apollo programs and followed by a discussion of the many valuable social/scientific application of aeronautics technologies, many of which were realized through the launching of successful satellite projects. The further solar system explorations of the Voyager missions are described, as it the Challenger tragedy and the 1988 return to space of the Shuttle program. Future plans are outlined for a cooperatively funded international space station to foster the ongoing study of space science. Author

N89-26806# Office of the Deputy Under Secretary of Defense for Research and Development (Research and Advanced Technology), Washington, DC.

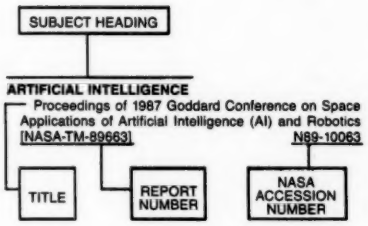
DEPARTMENT OF DEFENSE STATEMENT ON SCIENCE AND TECHNOLOGY TO THE SUBCOMMITTEE ON RESEARCH AND DEVELOPMENT OF THE COMMITTEE ON ARMED SERVICES, UNITED STATES HOUSE OF REPRESENTATIVES, 101ST CONGRESS, FIRST SESSION

George P. Millburn 23 Mar. 1989 36 p

(AD-A206584) Avail: NTIS HC A03/MF A01 CSCL 05/1

This statement describes the need for the DoD Science and Technology Program and management aspects such as the balanced technology initiative, the university research initiative, independent research and development, transferring technology to deployed systems, investment strategy and critical technologies. Also covered are the technology programs concerning research, weapons, technology, vehicular mobility technology, electronics technology, environmental and life sciences, support technology, and software and computer technology. GRA

Typical Subject Index Listing



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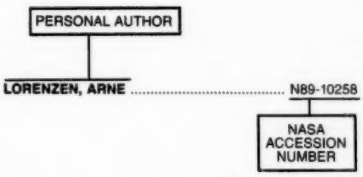

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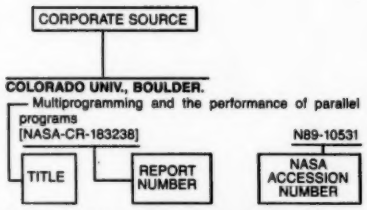

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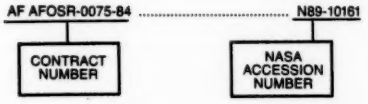

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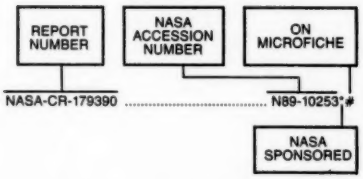

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